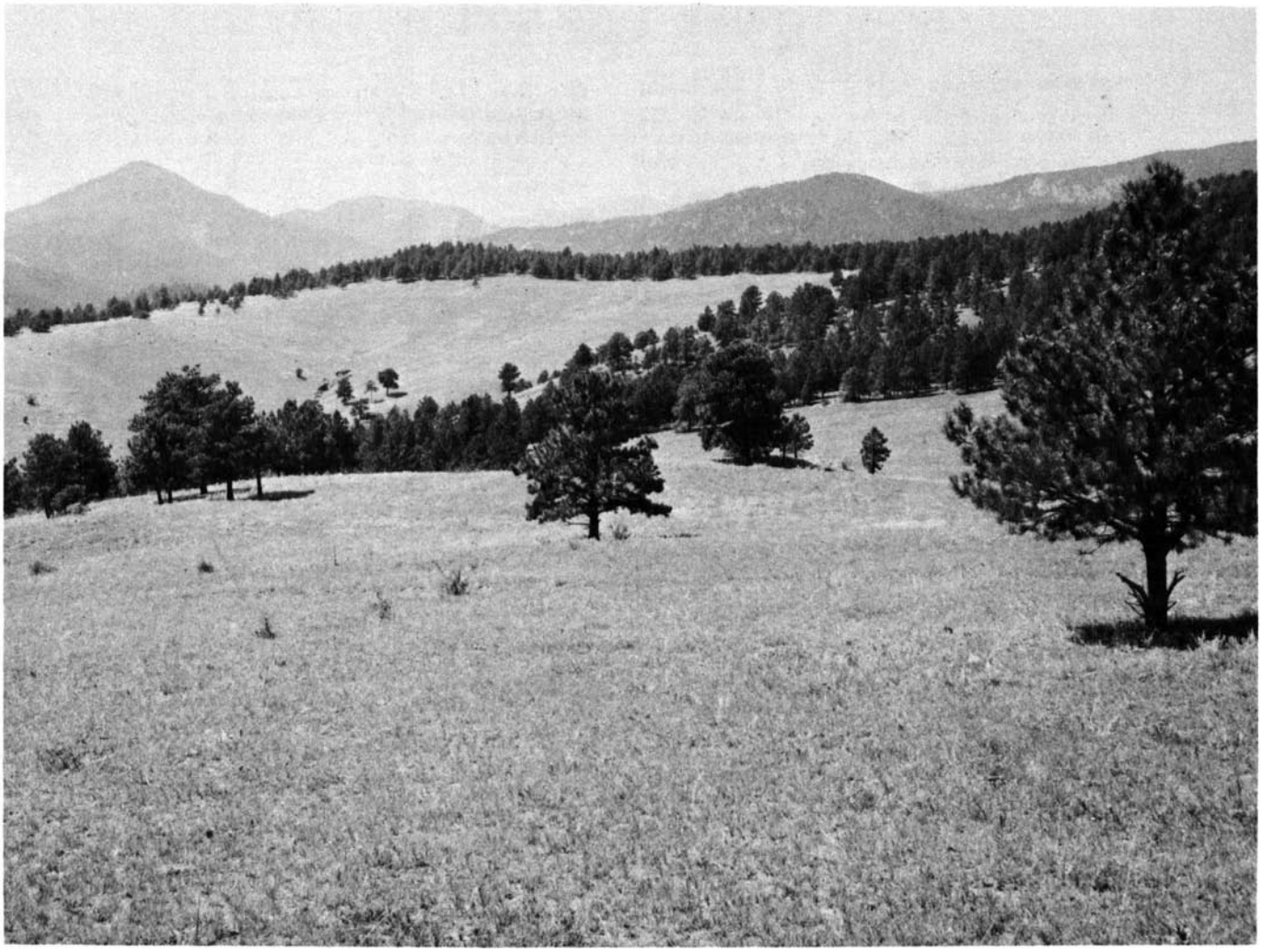
SOIL SURVEY OF

Boulder County Area, Colorado



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Colorado Agricultural Experiment Station

Issued January 1975

Major fieldwork for this soil survey of the Boulder County Area, Colorado, was done in the period 1960–67. Soil names and descriptions were approved in 1971. Unless otherwise indicated, all statements in this survey refer to conditions in the Area at the time mapping was in progress. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station; it is part of the technical assistance furnished to the Longmont and Boulder Valley Soil Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on indivi dual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Boulder County Area, Colorado, contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of the Boulder County Area are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, the page for irrigated and nonirrigated capability unit, and the tree suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of capability units and other interpretative groupings.

Foresters and others can refer to the section "Woodland and Tree Planting," where the soils of the Area are grouped according to their suitability for trees.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife."

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Urban Uses of the Soils."

Engineers and builders will find under "Engineering Uses of the Soils" tables that give engineering descriptions of the soils in the Area and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of the Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in the Boulder County Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area."

Cover picture: **Typical landscape of Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes.**

Contents

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SOIL SURVEY OF THE BOULDER COUNTY AREA, COLORADO

BY DONALD C. MORELAND AND RONALD E. MORELAND, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE COLORADO AGRICULTURAL EXPERIMENT STATION

BOULDER COUNTY AREA is in north-central Colorado. It makes up the eastern part of Boulder County (fig. 1) and is about 241,920 acres in size. The eastern part of the Area is rolling plains and valleys, and most of the acreage is irrigated cropland. The principal crops grown are corn, sugar beets, alfalfa, and small grain, although vegetable crops and beans are also grown. Cattle feeding is an important enterprise in this part of the Area. The western part of the Area is foothills and mountains. In the past, the acreage has been used for grazing livestock. In recent years, however, much of the Area has been used for urban and industrial development, and for recreational uses.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Boulder County Area, where they are located, and how they can be used.

They went into the Area knowing they likely would find many soils they had already seen, and perhaps some they had not. They observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

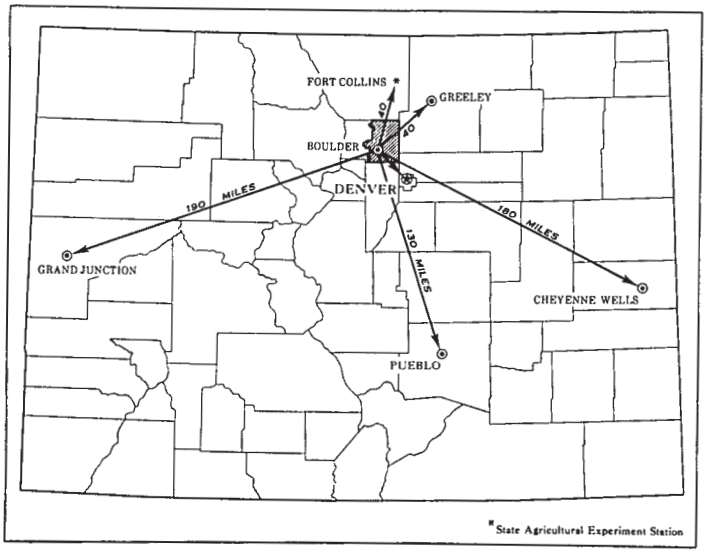

Figure 1.—Location of Boulder County Area in Colorado.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. The *soil series* and *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Weld and Nunn, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Soils of one series can differ in texture of their surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Weld loam, 0 to 1 percent slopes, is one of several phases within the Weld series, which in this Area has a slope range of 0 to 4 percent.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because they show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the map of the Boulder Area, soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils joined by a hyphen, for example, Weld-Colby complex, 0 to 3 percent slopes.

An association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map, but are shown instead as one unit because the time and effort needed for mapping them separately cannot be justified. In the Boulder Area survey for example, there is the Colby-Gaynor association.

In most areas surveyed, there are places so rocky, so shallow, or so frequently worked by wind and water that they cannot be classified as soil series. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Rock outcrop or Terrace escarpments, and are called land types rather than soil series.

Only part of the soil survey is done when the soil scientist has named and described the soil series and mapping units, and has shown the location of the mapping units on the soil map. The mass of detailed information he has recorded then needs to be presented in different ways for different groups of users, among them farmers, managers of woodlands, and engineers.

To do this efficiently, he consults persons in other fields of work and jointly prepares with them groupings of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture; tree suitability groups, for those who need to manage wooded tracts; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Boulder County Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in the Boulder Area are discussed in the following pages.

1. *Rock outcrop-Juget-Baller association*

Rock outcrop and sloping to very steep, shallow, very gravelly and stony soils on mountains

This association is made up of Rock outcrop and very gravelly and stony soils in mountains and ridges in the western part of the Boulder Area. This area is commonly called the foothills and front range of the southern Rocky Mountains. The soils in this association formed in residuum weathered from granite and sandstone. Slopes are 9 to 55 percent or more. Elevations range from about 5,500 to 8,200 feet. Annual precipitation is 16 to 24 inches. Mean annual air temperature is about 42° to 51° F., and the frost-free season is about 80 to 155 days.

This association makes up about 25 percent of the Area. It is about 35 percent Rock outcrop, about 15 percent Juget soils, and about 10 percent Baller soils. The remaining 40 percent is made up of Allens Park, Fern Cliff, Goldvale, Peyton, Pinata, and Sixmile soils, and Colluvial land (fig. 2).

Rock outcrop is throughout the association, but is mainly on very steep ridges and mountainsides. It consists of areas that have little soil or none at all.

Juget soils are throughout the western part of the association. They have a surface layer of very gravelly sandy loam and are underlain by granite at a depth of 20 inches or less.

Baller soils are on ridges in the eastern part of the association. They have a surface layer of stony sandy loam and are underlain by sandstone at a depth of 20 inches or less.

In the past, many areas of this association were used for grazing, forestry, and stone quarries. The native vegetation is mainly ponderosa pine with an understory of mid grasses. Some Rocky Mountain juniper is in the eastern part of the association at the lower elevations, and Engelmann spruce and Douglas-fir are in the western part at higher elevations.

In recent years many areas have been used as sites for homes and for recreational purposes. As this type of land use increases, the need for protecting the soils against erosion becomes greater. This is especially true where the vegetation is disturbed or removed by roadbuilding and clearing for homesites.

This association affords the best big game wildlife habitat in the Area. It is good for deer, and fair for bear and elk. It is also a fair habitat for dusky grouse.

2. *Nederland-Valmont association*

Nearly level to moderately steep, deep, very cobbly and cobbly soils on old high terraces, alluvial fans, and benches

This association is made up of nearly level to moderately steep old high terraces, benches, and alluvial fans in the west-central part of the Boulder Area. The soils formed in gravelly and cobbly alluvium. Slopes are 1 to 25 percent. Elevations range from 5,300 to 6,500 feet. Annual precipitation is 12 to 20 inches. Mean annual air

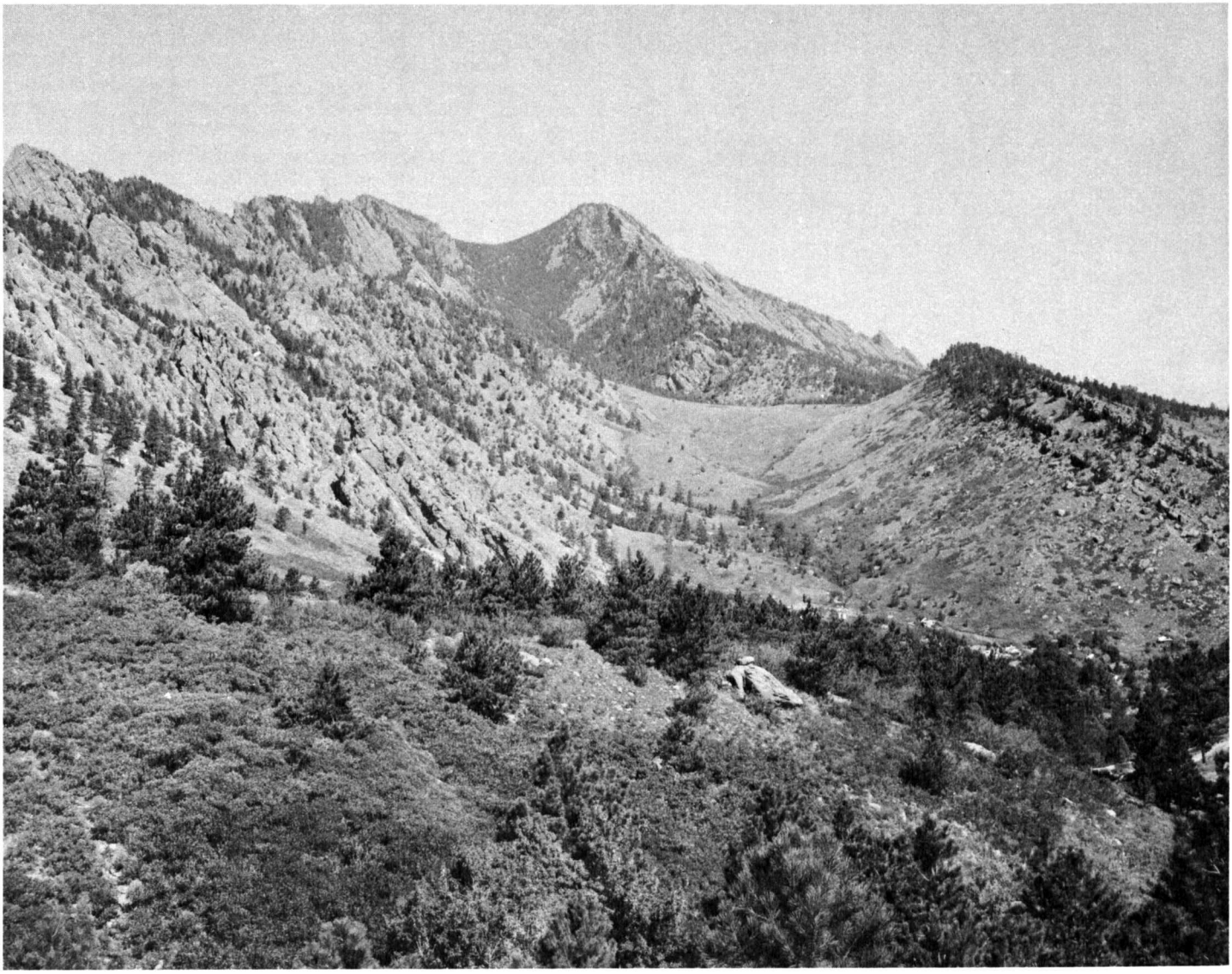

Figure 2.—**Typical landscape in the eastern part of Rock outcrop-Juget-Baller soil association.**

temperature is about 48° to 52° F., and the frost-free season is about 140 to 155 days.

This association makes up about 20 percent of the Area. It is about 25 percent Nederland soils and about 25 percent Valmont soils. The remaining 50 percent is made up of Nunn, Hargreave, Kutch, Laporte, Longmont, Renohill, and Samsil soils and Terrace escarpments.

Nederland soils are older, higher lying terraces and alluvial fans, mainly in the western part of the association. They have a surface layer of very cobbly sandy loam and a subsoil of very cobbly sandy clay loam.

Valmont soils are mainly near the eastern edge of high terraces and lower lying benches. They have a surface layer of cobbly clay loam or clay loam and a subsoil of clay and clay loam.

The northern areas of this association are mostly in grass and are used for grazing. The vegetation is mainly mid and tall grasses, such as big bluestem. In the southern part of the Area, urban development is taking place. This is because of the proximity to Boulder and the scenic view from some of the mesas.

A few areas that have fewer cobbles are used for irrigated and dryland crops and for pasture.

This association affords a fair habitat for cottontails, jackrabbits, and mourning doves.

3. *Samsil-Shingle association*

Gently sloping to moderately steep, shallow soils on shale or sandstone hills and ridges

This association is mainly on rolling uplands in the southeastern part and in the east-central part of the Boulder Area. Slopes are 3 to 25 percent. The soils in this association formed in residuum weathered from shale and sandstone. Elevations range from 4,900 to 5,500 feet. Annual precipitation is about 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is 140 to 155 days.

This association makes up about 5 percent of the Area. It is about 35 percent Samsil soils and about 30 percent Shingle soils. The remaining 35 percent is made up of Colby, Heldt, Kutch, Renohill, and Valmont soils.

Samsil soils are throughout the association, but mainly they are in the steeper areas. They have a surface layer of clay and are underlain by shale at a depth of 20 inches or less.

Shingle soils are throughout the association, but mainly they are in the steeper areas. They have a surface layer of loam and are underlain by shale or sandstone at a depth of 20 inches or less.

About half of the acreage of this association is used for dry pasture. The rest is used for range. The vegetation is mainly short grasses.

This association affords poor habitat for cottontails, jackrabbits, and mourning doves.

4. *Weld-Colby association*

Nearly level to sloping, deep soils on uplands

This association is on broad, nearly level to sloping uplands in the east-central and northeastern parts of the Boulder Area. The soils in this association formed in uniform windblown materials. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is 140 to 155 days.

This association makes up about 10 percent of the Area. It is about 35 percent Weld soils and about 35 percent Colby soils. Ascalon, Gaynor, Manvel, Nunn, and Otero soils make up the remaining 30 percent.

Weld soils are nearly level. They have a surface layer of loam, fine sandy loam, or loamy sand that is about 6 to 14 inches thick. The subsoil is clay or heavy clay loam.

Colby soils are mainly gently sloping to sloping. They have a surface layer and underlying layer of silty clay loam.

Almost all areas of this association are cultivated to irrigated crops. Good water management helps to control erosion. Where areas are not irrigated, stripcropping and summer fallow help to reduce erosion and conserve moisture.

This association is one of the best areas for upland bird habitat. It is good for pheasants and mourning doves. It is also fair for cottontails and jackrabbits, and for migratory waterfowl feeding areas.

5. *Ascalon-Nunn-Manter association*

Nearly level to moderately steep, deep soils on terraces, valley sides, and uplands

This association is on nearly level terraces and on gently sloping to moderately steep valley sides and uplands in the southeastern part of the Boulder Area. The soils in this association formed in mixed alluvial and windblown materials. Slopes are 0 to 20 percent. Elevations range from 4,900 to 5,500 feet. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is 140 to 155 days.

This association makes up about 10 percent of the Area. It is about 60 percent Ascalon soils, about 15 percent Nunn soils, and about 10 percent Manter soils. Hargreave, Colby, Weld, and Otero soils make up the remaining 15 percent.

Ascalon soils are nearly level soils on terraces and uplands. They have a surface layer of sandy loam and a subsoil of sandy clay loam.

Nunn soils are nearly level soils on terraces and valley side slopes. They have a surface layer of sandy clay loam or clay loam and a subsoil of clay.

Manter soils are on terraces and uplands. They have a surface layer and subsoil of sandy loam.

Most areas of this association are cultivated. About two-thirds of the association is used for irrigated crops. Where these areas are irrigated, good water management helps control erosion. Use of crop residue helps control soil blowing on both irrigated and dryfarmed areas.

This association is one of the best areas for upland bird habitat. It is good for pheasants and mourning doves. It is also fair for cottontails and jackrabbits, and for migratory waterfowl feeding areas.

6. *Nunn-Heldt association*

Nearly level to moderately sloping, deep soils on terraces and uplands

This association is on nearly level to moderately sloping terraces and uplands throughout the eastern part of the Boulder Area. The soils in this association formed from clay parent materials. Slopes are 0 to 9 percent. Elevations range from 4,900 to 5,500 feet. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is 140 to 155 days.

This association makes up about 20 percent of the Area. It is about 55 percent Nunn soils and about 15 percent Heldt soils. Ascalon, Colby, Gaynor, Kim, Kutch, Longmont, Renohill, Valmont, and Weld soils make up the remaining 30 percent.

Nunn soils are nearly level to moderately sloping soils on terraces and uplands throughout the association. They have a surface layer of clay loam or sandy clay loam and a subsoil of clay.

Heldt soils are nearly level to gently sloping. They have a surface layer and subsoil of clay.

Most areas of this association are used for irrigated crops. Good water management helps control erosion and prevents waterlogging.

This association provides a fair habitat for pheasants, mourning doves, and cottontails. It also provides a fair feeding area for migratory waterfowl.

7. *Niwot-Loveland-Calkins association*

Nearly level, deep soils on low terraces and bottom lands

This association occupies narrow, nearly level areas adjacent to major streams in the eastern part of the Boulder Area. The soils in this association formed from loamy alluvium. Slopes are 0 to 3 percent. Elevations range from 4,900 to 5,500 feet. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is 140 to 155 days.

This association makes up about 10 percent of the Area. It is about 35 percent Niwot soils, about 15 percent Loveland soils, and about 10 percent Calkins soils. Ascalon, Heldt, Manter, McClave, Nunn, and Valmont soils make up the remaining 40 percent.

Niwot soils have a surface layer of clay loam and loam and are underlain by gravelly sand at a depth of 10 to 20 inches.

Loveland soils have a surface layer and underlying material of clay loam. They are underlain by gravelly sand at a depth of 20 to 40 inches.

Calkins soils have a surface layer and underlying material of sandy loam.

All the major soils of this association are mottled and have a water table that is within the root zone at some time during the year.

About half of the acreage of this association is used for growing irrigated crops. The rest is used for irrigated pasture. Many areas have gravel pits. Because of the high water table, drainage practices help increase crop yields. In places, this association is flooded by runoff from adjacent areas.

This association is a potential site for habitat for waterfowl and fish. It is also fair for cottontails, but poor for deer, pheasants, mourning doves, and bobwhite.

Descriptions of the Soils

In this section the soils of Boulder County Area are described in detail and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is specifically mentioned otherwise, information about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described for the soil series is representative for the mapping units in that series. Colors are for dry soils unless otherwise noted. If a given mapping unit has a profile in some ways different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains information about how the mapping unit is now used.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Made land, for example, does not belong to a soil series, but it is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit is the capability unit and tree suitability group in which the mapping unit has been placed. The "Guide to Mapping Units" at the back of this survey gives the page for the description of each capability unit.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary.

Allens Park Series

The Allens Park series is made up of moderately deep, well-drained soils. These soils formed on mountain slopes in loamy colluvium and residuum weathered from granite. Slopes are 15 to 60 percent. Elevations are 6,300 to 8,200 feet. The native vegetation is mainly a forest of ponderosa pine and Douglas-fir with a sparse understory of grass. Annual precipitation is 18 to 24 inches. Mean annual air temperature is 43° to 47° F., and the frost-free season is about 80 to 120 days.

In a representative profile the surface layer, about 2 inches thick, is dark-gray gravelly sandy loam. The subsurface layer, about 8 inches thick, is light brownish-gray gravelly sandy loam. Below this is light grayish-brown gravelly sandy loam that has seams and nodules of brown gravelly sandy clay loam in the lower part. The subsoil is brown gravelly sandy clay loam about 9 inches thick. Partly weathered granite underlies the subsoil at a depth of about 26 inches. Soil reaction in the surface layer is neutral, and in the subsoil it is slightly acid.

Allens Park soils have moderate permeability. Available water capacity for the profile is low. Roots can penetrate to a depth of between 20 and 40 inches.

These soils are not suitable for tillage. They are used for timber production, grazing, recreational purposes, and homesites.

Representative profile of Allens Park gravelly sandy loam in an area of Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes, located in tract 47 of an unsectionized area, 1,900 feet east and 450 feet south of the southwest corner of sec. 16, T. 1 S., R. 71 W.:

O1—3 to 2 inches, undecomposed forest litter.
O2—2 inches to 0, partially decomposed litter.
A1—0 to 2 inches, dark-gray (10YR 4/1) gravelly sandy loam, very dark gray (10YR 3/1) when moist; moderate, fine, crumb structure; soft, very friable; neutral; gradual, smooth boundary.
A2—2 to 10 inches, light brownish-gray (10YR 6/2) gravelly sandy loam, grayish brown (10YR 5/2) when moist; weak, medium, platy structure that parts to moderate, fine, granular; soft, very friable; neutral; gradual, wavy boundary.
B&A—10 to 17 inches, light grayish-brown (10YR 6/2) gravelly sandy loam with seams and nodules of brown (10YR 5/3) gravelly sandy clay loam, grayish brown (10YR 5/2) and brown (10YR 5/3) when moist; weak, medium, subangular blocky structure and moderate, fine, granular; slightly hard, very friable; thin, patchy clay films on ped faces; slightly acid; gradual, wavy boundary.
B2t—17 to 26 inches, brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, friable; thin, continuous clay films on ped faces; slightly acid; gradual, wavy boundary.
C—26 inches, partially weathered granite.

The A1 horizon ranges from 0 to 4 inches in thickness. Depth to underlying granite ranges from 20 to 40 inches. Content of coarse fragments ranges from 0 to 35 percent.

In this survey area the Allens Park soils are manned only with the Fern Cliff soils.

Ascalon Series

The Ascalon series is made up of deep, well-drained soils. These soils formed on terraces and uplands in loamy mixed alluvium and wind-laid materials. Slopes are 0 to

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Ascalon sandy loam, 0 to 1 percent slopes	1, 300	0. 5	McClave clay loam	2, 300	1. 0
Ascalon sandy loam, 1 to 3 percent slopes	11, 000	4. 5	Nederland very cobbly sandy loam, 1 to 12 percent slopes	11, 700	4. 8
Ascalon sandy loam, 3 to 5 percent slopes	4, 800	2. 0	Niwot soils	9, 100	3. 8
Ascalon sandy loam, 5 to 9 percent slopes	900	. 4	Nunn sandy clay loam, 0 to 1 percent slopes	1, 700	. 7
Ascalon-Otero complex, 0 to 3 percent slopes	1, 200	. 5	Nunn sandy clay loam, 1 to 3 percent slopes	3, 400	1. 4
Ascalon-Otero complex, 3 to 5 percent slopes	2, 600	1. 0	Nunn clay loam, 0 to 1 percent slopes	6, 800	2. 8
Ascalon-Otero complex, 5 to 9 percent slopes	2, 400	1. 0	Nunn clay loam, 1 to 3 percent slopes	15, 300	6. 3
Ascalon-Otero complex, 9 to 20 percent slopes	1, 700	. 7	Nunn clay loam, 3 to 5 percent slopes	5, 300	2. 2
Baller stony sandy loam, 9 to 35 percent slopes	7, 700	3. 2	Nunn clay loam, 5 to 9 percent slopes	1, 100	. 5
Calkins sandy loam, 0 to 1 percent slopes	1, 600	. 7	Nunn-Kim complex	2, 600	1. 0
Calkins sandy loam, 1 to 3 percent slopes	1, 700	. 7	Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes	2, 300	1. 0
Colby silty clay loam, 1 to 3 percent slopes	4, 300	1. 8	Pinata-Rock outcrop complex, 5 to 55 percent slopes	5, 200	2. 1
Colby silty clay loam, 3 to 5 percent slopes	2, 200	. 9	Renohill loam, 3 to 9 percent slopes	1, 300	. 5
Colby silty clay loam, 5 to 9 percent slopes	1, 000	. 4	Renohill silty clay loam, 1 to 3 percent slopes	1, 100	. 5
Colby silty clay loam, wet, 0 to 3 percent slopes	600	. 2	Renohill silty clay loam, 3 to 9 percent slopes	2, 200	. 9
Colby-Gaynor association	1, 100	. 5	Rock outcrop	6, 500	2. 7
Colluvial land	5, 800	2. 4	Samsil clay, 3 to 12 percent slopes	2, 600	1. 0
Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes	12, 700	5. 2	Samsil-Shingle complex, 5 to 25 percent slopes	5, 800	2. 4
Gaynor silty clay loam, 1 to 3 percent slopes	400	. 2	Shingle-Gaynor complex, 3 to 20 percent slopes	1, 100	. 5
Gaynor silty clay loam, 3 to 9 percent slopes	900	. 4	Sixmile stony loam, 10 to 50 percent slopes	3, 100	1. 3
Goldvale-Rock outcrop complex, 9 to 55 percent slopes	2, 900	1. 2	Terrace escarpments	8, 300	3. 4
Hargreave fine sandy loam, 1 to 3 percent slopes	1, 100	. 5	Valmont clay loam, 1 to 3 percent slopes	5, 200	2. 1
Hargreave fine sandy loam, 3 to 9 percent slopes	900	. 4	Valmont clay loam, 3 to 5 percent slopes	1, 200	. 5
Heldt clay, 0 to 3 percent slopes	4, 700	1. 9	Valmont cobbly clay loam, 1 to 5 percent slopes	5, 500	2. 3
Heldt clay, 3 to 5 percent slopes	2, 000	. 8	Valmont cobbly clay loam, 5 to 25 percent slopes	1, 600	. 7
Juget-Rock outcrop complex, 9 to 55 percent slopes	20, 700	8. 5	Weld loamy sand, 1 to 4 percent slopes	220	. 1
Kutch clay loam, 3 to 9 percent slopes	2, 600	1. 0	Weld fine sandy loam, 1 to 3 percent slopes	1, 400	. 6
Laporte very fine sandy loam, 5 to 20 percent slopes	1, 200	. 5	Weld loam, 0 to 1 percent slopes	500	. 2
Longmont clay, 0 to 3 percent slopes	2, 800	1. 2	Weld loam, 1 to 3 percent slopes	3, 400	1. 4
Loveland soils	4, 500	1. 9	Weld-Colby complex, 0 to 3 percent slopes	1, 900	. 8
Made land	200	. 1	Weld-Colby complex, 3 to 5 percent slopes	500	. 2
Manter sandy loam, 0 to 1 percent slopes	400	. 2	Gravel pits and Mine dumps	700	. 3
Manter sandy loam, 1 to 3 percent slopes	2, 100	. 9	Water	5, 900	2. 4
Manter sandy loam, 3 to 9 percent slopes	1, 000	. 4	Total	241, 920	100. 0
Manvel loam	2, 100	. 9			

20 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly blue grama. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is grayish-brown sandy loam about 8 inches thick. The subsoil reaches to a depth of 26 inches. It is brown sandy clay loam in the upper part and strongly calcareous, light yellowish-brown sandy loam in the lower part. The substratum, to a depth of 60 inches or more, is strongly calcareous, very pale brown sandy loam. In the surface layer, soil reaction is neutral, but with increasing depth the reaction becomes moderately alkaline.

Ascalon soils have moderate permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

Most of the acreage of these soils is used for irrigated and dry cropland, but use as homesites is increasing.

Representative profile of Ascalon sandy loam, 1 to 3 percent slopes, located 800 feet north and 2,590 feet east of the southwest corner of sec. 27, T. 1 N., R. 69 W.:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to weak, fine, granular; slightly hard, very friable; neutral; clear, smooth boundary.

B1t—8 to 12 inches, brown (10YR 5/3) light sandy clay loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that parts to moderate, medium, subangular blocky; hard, friable; few patchy clay films on ped faces; neutral; clear, smooth boundary.

B2t—12 to 19 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard, friable; thin, nearly continuous clay films on ped faces; mildly alkaline; clear, smooth boundary.

B3tca—19 to 26 inches, light yellowish-brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic structure that parts to weak, medium, subangular blocky; hard, very friable; thin, patchy clay films on ped faces; strongly calcareous; moderately alkaline; gradual, wavy boundary.

Cca—26 to 60 inches, very pale brown (10YR 7/4) sandy loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard, very friable; strongly calcareous; moderately alkaline.

The A1 horizon ranges from 6 to 11 inches in thickness. The B1 horizon is absent in some places. Depth to lime ranges from 15 to 30 inches.

Ascalon sandy loam, 0 to 1 percent slopes (AcA).—This soil is mainly in the eastern part of the Area. It occurs as irregularly shaped areas larger than 15 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 11 inches thick.

Included with this soil in mapping are areas less than 5 acres in size that have a water table at a depth of 4 to 5 feet. Where the land has been leveled, there are small areas that have a thinner or thicker topsoil. Also included are small areas of Ascalon sandy loam, 1 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is slow on this soil. The erosion hazard is slight.

All of the acreage of this soil is used for irrigated crops. (Capability unit I, irrigated; tree suitability group 4)

Ascalon sandy loam, 1 to 3 percent slopes (AcB).—This soil is in the eastern part of the Area. It occurs as irregularly shaped areas, mainly more than 20 acres in size.

Included with this soil in mapping are a few wet areas that have a water table at a depth of between 4 and 5 feet. These areas are 2 to 5 acres in size. Where the land has been leveled, areas less than 5 acres in size have a thinner or thicker topsoil. Also included are small areas of Ascalon sandy loam, 3 to 5 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is slow to medium on this soil. The erosion hazard is slight to moderate.

About two-thirds of the acreage of this soil is used for irrigated crops. The remaining third is used for dryland crops. (Capability units IIe–2, irrigated, and IIIe–8, nonirrigated; tree suitability group 4)

Ascalon sandy loam, 3 to 5 percent slopes (AcC).—This soil is mainly in the eastern part of the Area. It occurs as irregularly shaped areas that are ordinarily more than 15 acres in size.

The profile of this soil is much like the one described as representative for the series, but deep plowing has mixed the surface layer with the upper part of the subsoil.

Included with this soil in mapping, where the land has been leveled or where it has been eroded, are areas that have a thinner surface layer. Some areas near ridge crests have a thinner subsoil. Also included are areas where cobblestones are on the surface, and small areas of Ascalon sandy loam, 1 to 3 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The hazards of water erosion and soil blowing are moderate to high.

About two-thirds of the acreage of this soil is used for irrigated cropland and for pasture. The remaining third is used for dry cropland. (Capability units, IIIe–6, irrigated, and IVe–7, nonirrigated; tree suitability group 4)

Ascalon sandy loam, 5 to 9 percent slopes (AcD).—This soil is mainly in the eastern part of the Area. In most places it occurs as long and narrow areas less than 20 acres in size.

The profile of this soil is much like the one described as representative for the series, but in places the surface layer is about 6 or 7 inches thick.

Included with this soil in mapping are small areas less than 2 acres in size having sandstone or shale at a depth of less than 30 inches. Also included is Otero sandy loam, Ascalon sandy loam, 3 to 5 percent slopes, and areas that have a surface layer of sandy clay loam. These inclusions make up about 20 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

Almost all of the acreage of this soil is cultivated. (Capability units IVe–3, irrigated, and IVe–7, nonirrigated; tree suitability group 4)

Ascalon-Otero complex, 0 to 3 percent slopes (AoB).—This complex is in the eastern part of the Area. It is made up of about 60 percent Ascalon sandy loam and about 30 percent Otero sandy loam. Ascalon sandy loam is on the more nearly level part of the landscape that has received little or no leveling. Otero sandy loam is on the more sloping part that has been leveled with deep cuts.

Ascalon sandy loam has a profile much like the one described as representative for the series, but in some areas that have been leveled or eroded, the surface layer is thicker or thinner.

Otero sandy loam has a profile similar to the one described as representative for the Otero series, but the surface layer is about 17 inches thick.

Included with this complex in mapping are small areas of Kim soils and some areas of Ascalon-like soils that have a lighter colored surface layer. These included soils make up about 10 percent of each mapped area.

Runoff is slow to medium on this complex. The erosion hazard is moderate.

All of the acreage of this complex is used for irrigated and dryland crops. Maintenance of organic-matter content is important, particularly on areas where the surface layer has been removed by leveling. Some areas near the larger towns are being converted to urban uses. (Capability units IIe–2, irrigated, and IIIe–8, nonirrigated; tree suitability group 4)

Ascalon-Otero complex, 3 to 5 percent slopes (AoC).—This complex is in the eastern part of the Area. It is about 55 percent Ascalon sandy loam and about 35 percent Otero sandy loam. Ascalon sandy loam is on the smoother slopes and below the crests of the ridges. Otero sandy loam is on the tops of the ridges and in areas that have been leveled.

Ascalon sandy loam has a profile similar to the one described as representative for the series, but the surface layer is about 6 inches thick. In some places the surface layer is lighter colored than typical.

Otero sandy loam has a profile similar to the one described as representative for the Otero series, but the surface layer is about 10 inches thick.

Included with this complex in mapping are small areas of Kim soils and a few small areas of Weld fine sandy loam, 1 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is medium on the major soils of this complex. The erosion hazard is moderate to high.

All of the acreage of this complex is used for irrigated and dryland crops and for pasture. Maintenance of

organic-matter content and tilth is important. (Capability units IIIe–6, irrigated, and IVe–7, nonirrigated; tree suitability group 4)

Ascalon-Otero complex, 5 to 9 percent slopes (AoD).—This complex is in the eastern part of the Area. It is about 50 percent Ascalon sandy loam and 35 percent Otero sandy loam. Ascalon sandy loam is less sloping than Otero sandy loam, which is on ridgetops and is steeper.

Ascalon sandy loam has a profile much like the one described as representative for the series, but the surface layer is about 6 inches thick.

Otero sandy loam has a profile much like the one described as representative for the Otero series, but the surface layer is about 8 inches thick.

Included with these soils in mapping are small areas of Kim soils, a few small areas having sandstone at varying depths, outcrops of sandstone along some of the drainageways, and small gravelly knobs less than 2 acres in size on the ridgetops. These included soils, outcrops, and gravelly knobs make up about 15 percent of each mapped area.

Runoff is rapid on the soils of this complex. The erosion hazard is high.

All of the acreage of this soil complex is used for irrigated and dryland crops and for pasture. (Capability units IVe–3, irrigated, and IVe–7, nonirrigated; tree suitability group 4)

Ascalon-Otero complex, 9 to 20 percent slopes (AoE).—This complex is in the eastern part of the Area. It is about 45 percent Ascalon sandy loam and 35 percent Otero sandy loam. The Ascalon soils are less sloping than the Otero soils.

Ascalon sandy loam has a profile much like the one described as representative for the series, but the surface layer is about 6 inches thick. In some areas that have been plowed deeply, the sandy clay loam subsoil is mixed with the surface layer.

Otero sandy loam has the profile described as representative for the Otero series.

Included with this complex in mapping are small areas of Kim soils, areas of sandstone outcrop less than 2 acres in size along drainageways, and small gravelly knobs near ridgetops. These included areas make up about 20 percent of the acreage mapped as this complex.

Runoff is rapid on this complex. The erosion hazard is high.

All of the acreage of this complex is used for dryland crops and for pasture. A few small areas are in native grass. (Capability unit VIe–2, nonirrigated; tree suitability group 4)

Baller Series

The Baller series is made up of shallow, well-drained soils. These soils formed on upland ridges in loamy residuum weathered from sandstone. Slopes are 9 to 35 percent. Elevations are 5,500 to 6,500 feet. The native vegetation is mainly mid grasses and scattered ponderosa pine and Rocky Mountain juniper. Annual precipitation is 16 to 20 inches. Mean annual air temperature is 47° to 51° F., and the frost-free season is 140 to 155 days.

In a representative profile the surface layer is grayish-brown stony sandy loam about 10 inches thick. The underlying layer, about 5 inches thick, is light brownish-gray very stony sandy loam that overlies sandstone. Soil reaction is neutral.

Baller soils have rapid permeability. Available water capacity for the profile is low. Roots can penetrate to a depth of between 10 and 20 inches.

These soils are used for range and homesites.

Representative profile of Baller stony sandy loam, 9 to 35 percent slopes, located 1,400 feet south and 500 feet west of the northeast corner of sec. 6, T. 2 N., R. 70 W.:

A1—0 to 10 inches, grayish-brown (10YR 5/2) stony sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, very friable; 50 percent stones and cobbles; neutral; clear, smooth boundary.

C—10 to 15 inches, light brownish-gray (10YR 6/2) very stony sandy loam, dark grayish brown (10YR 5/2) when moist; massive; slightly hard, very friable; 60 percent stones and cobbles; neutral; gradual, wavy boundary.

R—15 inches, hard sandstone.

The A horizon ranges from 6 to 16 inches in thickness. Sandstone bedrock is at a depth of 10 to 20 inches. The average rock fragment content of the soil ranges from about 50 to 60 percent and is dominantly of stone size (more than 10 inches in diameter).

Baller stony sandy loam, 9 to 35 percent slopes (BaF).—This soil is on the east slopes of ridges in the western part of the Area. In most places it is in areas more than 100 acres in size. Large amounts of stone are on the surface and throughout the profile.

Included with this soil in mapping are small areas near the bottoms of slopes that have a sandy loam surface layer and a sandy clay loam subsoil. Near drainageways are areas that are deeper to bedrock. Also included, mostly near ridgetops, are small areas of Rock outcrop. The included soils and Rock outcrop make up about 20 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

All of the acreage of this soil is in native grass. In some places there are scattered stands of ponderosa pine. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Calkins Series

The Calkins series is made up of deep, somewhat poorly drained soils. They formed in loamy alluvium on low terraces and bottom lands. Slopes are 0 to 3 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly meadow grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 40 inches thick, is grayish-brown sandy loam. Underlying this to a depth of 60 inches or more is light brownish-gray coarse sandy loam that contains many brown mottles. Soil reaction is neutral.

Calkins soils have moderate to rapid permeability. Available water capacity for the profile is moderate to high. Roots can penetrate to a depth of 60 inches or more, and the seasonal high water table is at a depth of 3 feet or less.

These soils are used for irrigated crops and for pasture.

Representative profile of Calkins sandy loam, 0 to 1 percent slopes, located 400 feet east and 100 feet north of the southwest corner of sec. 16, T. 2 N., R. 69 W.:

Ap—0 to 14 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure that parts to weak, medium, granular; hard, friable; neutral; clear, smooth boundary.

A1—14 to 40 inches, grayish-brown (10YR 5/2) sandy loam with common, medium, distinct, brown (7.5YR 5/4) mottles, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to fine granular; slightly hard, very friable; neutral; gradual, wavy boundary.

C—40 to 60 inches, light brownish-gray (10YR 6/2) coarse sandy loam, dark grayish brown (10YR 4/2) when moist; many, fine, brown (7.5YR 4/4) mottles; massive; slightly hard, very friable; neutral.

The A horizon ranges from 24 to 40 inches in thickness and from fine sandy loam to sandy loam in texture. In some places these soils are calcareous below a depth of 40 inches.

Calkins sandy loam, 0 to 1 percent slopes (CaA).—This soil is on stream terraces and bottoms in the eastern part of Area. In most places it occurs as areas more than 30 acres in size. The profile of this soil is the one described as representative for the Calkins series.

Included with this soil in mapping are small areas that have a sandy clay loam texture throughout the profile, and a few small areas that are limy. Also included are small areas of McClave clay loam. These inclusions together make up about 10 percent of the acreage of this soil.

Runoff is slow on this soil. The erosion hazard is slight.

All of the acreage of this soil is used for irrigated crops. (Capability unit IIw–2, irrigated; tree suitability group 5)

Calkins sandy loam, 1 to 3 percent slopes (CaB).—This soil is on stream terraces and bottoms in the eastern part of the Area. In most places it occurs as long, narrow areas more than 20 acres in size.

Included with this soil in mapping are small areas of Calkins sandy loam, 0 to 1 percent slopes, and McClave clay loam. These included soils make up about 15 percent of each mapped area.

Runoff is slow on this soil. The erosion hazard is moderate.

All of the acreage of this soil is used for irrigated crops. (Capability unit IIw–2, irrigated; tree suitability group 5)

Colby Series

The Colby series is made up of deep, well-drained soils. These soils formed on upland slopes in loamy, uniform wind-deposited material. Slopes are 1 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 14 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is brown silty clay loam about 12 inches thick. Underlying this is pale-brown and light yellowish-brown silty clay loam and clay loam about 48 inches thick. Soil reaction is moderately alkaline. This soil is strongly calcareous throughout the profile. It contains soft lime segregations below a depth of 43 inches.

Colby soils have moderate permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Colby silty clay loam, 1 to 3 percent slopes, located 350 feet north and 11 feet west of the southeast corner of sec. 14, T. 2 N., R. 69 W.:

Ap—0 to 12 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium and coarse, subangular blocky structure that parts to weak, medium and fine, granular; slightly hard, friable; strongly calcareous; moderately alkaline; clear, smooth boundary.

C1—12 to 43 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; massive; hard, friable; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2ca—43 to 60 inches, light yellowish-brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) when moist; massive; hard, friable; strongly calcareous with few, fine to coarse, soft, white lime segregations; moderately alkaline.

The A horizon is typically silty clay loam in texture, but in some places it ranges from silt loam to silty clay loam. The C horizon is light silty clay loam, clay loam, or silt loam in texture. Colby silty clay loam, wet, 0 to 3 percent slopes, is faintly mottled and finer textured in the C horizon than is the Colby series, but it is included in this survey because it is of limited acreage.

Colby silty clay loam, 1 to 3 percent slopes (CoB).—This soil is on the uplands, mainly in the northeastern part of the Area. In most places it occurs as irregular areas more than 20 acres in size.

Included with this soil in mapping are small areas of Weld loam, 1 to 3 percent slopes; Gaynor silty clay loam, 1 to 3 percent slopes; and Colby silty clay loam, wet, 0 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate.

Almost all of the acreage of this soil is used for irrigated or dryland crops. A few small areas are in grass. (Capability units IIe–1, irrigated, and IVe–4, nonirrigated; tree suitability group 3)

Colby silty clay loam, 3 to 5 percent slopes (CoC).—This soil is on the uplands, mainly in the northeastern part of the Area. In most places it is in irregular areas larger than 15 acres in size.

Included with this soil in mapping are some small areas of Gaynor silty clay loam, 3 to 9 percent slopes; and Colby silty clay loam, wet, 0 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate to high.

Almost all of the acreage of this soil is used for irrigated and dryland crops. A few small areas are in pasture. (Capability units IIIe–2, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Colby silty clay loam, 5 to 9 percent slopes (CoD).—This soil is on the uplands, mainly in the northeastern part of the Area. In most places it is in areas of more than 15 acres.

Included with this soil in mapping are small areas of Gaynor silty clay loam, 3 to 9 percent slopes, and Renohill silty clay loam, 3 to 9 percent slopes. These included soils make up about 20 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

About 70 percent of the acreage of this soil is used for irrigated or dryland crops. The remaining third is used for pasture. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Colby silty clay loam, wet, 0 to 3 percent slopes (CsB).—This soil is in upland valleys in the northeastern part of the Area. Most areas are irregularly shaped and more than 15 acres in size.

The profile of this soil is much like the one described as representative for the series, but the underlying material is a stratified calcareous silty clay loam and light silty clay that has salt accumulations. The lower part of the underlying material is faintly mottled.

Included with this soil in mapping are small areas of Colby silty clay loam, 1 to 3 percent slopes; and Weld loam, 1 to 3 percent slopes. These make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is slight to moderate. As a result of irrigation on higher lying soils, mainly during summer, a seasonal high water table is at a depth of 2 to 4 feet in this soil.

Most of the acreage of this soil is cultivated, but some areas are used for irrigated pasture. (Capability unit IIw–1, irrigated; tree suitability group 6)

Colby-Gaynor association (5 to 9 percent slopes) (Ct).—This association is on the uplands, mainly in the northeastern part of the Area. It is about 55 percent Colby silty clay loam, and about 30 percent Gaynor silty clay loam. The Colby soil is near the tops and the bottoms of slopes, and the Gaynor is mainly in the steeper middle part.

Included with this association in mapping are a few small areas of Shingle loam, of Kim soils, and of small gravel-capped knobs. These make up about 15 percent of each mapped area.

Runoff is rapid on this soil association. The erosion hazard is high.

All of the acreage of this soil association is used for irrigated or dryland crops or for pasture. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Colluvial Land

Colluvial land (Cu) is in long narrow valleys in the western part of the Area. This land type varies widely in depth, texture, color, reaction, and stoniness. The surface layer is mainly a sandy loam that contains varying amounts of stones and cobbles. The underlying material ranges from loamy sand to clay. The soil material ranges from shallow to deep. Lime content ranges from strongly calcareous to noncalcareous, and reaction ranges from neutral to moderately alkaline. Most areas are dark colored, but some are light colored.

Colluvial land receives runoff from adjacent slopes. The erosion hazard is high. Most areas of Colluvial land have stones and cobbles on the surface that interfere with cultivation.

Most of the acreage is used for grass. Some small local areas that were once farmed have been reseeded to grass. These reseeded areas have fewer stones on the surface. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Fern Cliff Series

The Fern Cliff series is made up of deep, well-drained soils. These soils formed in loamy mixed alluvium on short fans and valley side slopes in the mountain area. Slopes are 15 to 60 percent. Elevations are 6,300 to 8,200 feet. The native vegetation is mainly a forest of ponderosa pine and Douglas-fir with a sparse understory of grass. Annual precipitation is 18 to 24 inches. Mean annual air temperature is 43° to 47° F., and the frost-free season is about 80 to 120 days.

In a representative profile the surface layer is dark grayish-brown stony sandy loam about 3 inches thick. The subsurface layer, about 17 inches thick, is light-gray stony sandy loam. The upper part of the subsoil, about 9 inches thick, is light-gray and yellowish-brown stony sandy loam and sandy clay loam. The sandy clay loam is in thin layers and bands in the sandy loam. The lower part of the subsoil is light brownish-gray and yellowish-brown stony sandy clay loam and sandy loam about 31 inches thick. Below this is light yellowish-brown sandy loam that contains many stones.

Fern Cliff soils have moderate to moderately rapid permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 60 inches or more. Moderate amounts of stone are on the surface and throughout the profile.

Reaction in the upper part of the surface layer is slightly acid, and in the subsurface layer it is medium acid. In the subsoil and substratum it is slightly acid.

These soils are used for pasture, for recreation and forestry, and for homesites.

Typical profile of Fern Cliff stony sandy loam in Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes, located 1,400 feet south and 2,400 feet west of the northeast corner of sec .5, T. 1 N., R. 71 W.:

O1—4 inches to 2, undecomposed organic material, chiefly needles, bark, and twigs.

O2—2 inches to 0, partially decomposed organic matter like that of the horizon above.

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) stony sandy loam, very dark brown (10YR 2/2) when moist; strong, fine, crumb structure; soft, very friable; 15 to 20 percent stone; slightly acid; clear, smooth boundary.

A2—3 to 20 inches, light-gray (10YR 7/2) sandy loam, grayish brown (10YR 5/2) when moist; weak, fine, platy structure that parts to moderate fine granular; soft, very friable; 15 to 20 percent stone; medium acid; gradual, wavy boundary.

A&B—20 to 29 inches, light-gray (10YR 7/2) stony heavy sandy loam, grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure; horizon contains thin, discontinuous, yellowish-brown (10YR 5/4) sandy clay loam lamellae and seams that are dark yellowish brown (10YR 4/4) when moist; in some places a soft matrix and very hard lamellae, and in others a very friable matrix and friable lamellae; thin, nearly continuous clay films on ped faces in lamellae; 20 percent of soil horizon is stone; horizon is slightly acid; diffuse, wavy boundary.

B&A—29 to 60 inches, yellowish-brown (10YR 5/4) stony clay loam in ½- to 2-inch thick discontinuous lamellae; these lamellae are dark yellowish brown (10YR 4/4) when moist, and interspersed between them is light brownish-gray (10YR 4/2) heavy sandy loam material like that of the horizon above; dark grayish brown (10YR 4/2) when moist; lamellae have moderate, medium, subangular blocky structure, and interspersed material is massive; lamellae are very hard and friable and interspersed material is slightly hard and very friable; lamellae have thin, continuous clay films on ped faces; this horizon is 20 percent stone; slightly acid; gradual, wavy boundary.

C—60 to 80 inches, light yellowish-brown (2.5Y 6/3) very stony sandy loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, very friable; 60 percent stone; slightly acid.

The A1 horizon ranges from 0 to 4 inches in thickness, and in some places it is absent. The A2 horizon ranges from loamy sand to sandy loam in texture. Content of coarse fragments ranges from 5 to 35 percent throughout the solum, but reaches as high as 60 or 70 percent in the C horizon. Depth to bedrock is 60 inches or more.

Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes (FcF).—This complex is made up of about 30 percent Fern Cliff stony sandy loam, about 30 percent Allens Park gravelly sandy loam, and about 20 percent Rock outcrop. This complex is in the western part of the Area.

Fern Cliff soils are on mountain side slopes and short fans. Allens Park soils are on ridges and side slopes, and on saddles between the ridges. Rock outcrop is throughout the Area, but mainly on ridges.

Included with this complex in mapping are minor areas of Fern Cliff stony loamy sand, Juget soils, Peyton soils, and narrow bands of alluvial soils along drainageways. These included soils make up about 20 percent of each mapped area.

Runoff is medium to rapid on areas of this complex. The erosion hazard is high.

All of the acreage of this complex is woodland. Timber cutting is somewhat limited by the steep slope and the slow growth of trees. Some areas are used for grazing. Many areas are now used as sites for cabins and homes, and for recreational uses and wildlife habitat. (Capability unit VIIe–1, nonirrigated; tree suitability group 1)

Gaynor Series

The Gaynor series is made up of moderately deep, well-drained soils. These soils formed on uplands in loamy alluvium and wind-laid materials. Slopes are 1 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is light olive-brown silty clay loam about 6 inches thick. Below this is light olive-brown silty clay loam about 4 inches thick. The underlying material is light yellowish-brown silty clay loam about 20 inches thick. Underlying this is soft calcareous silty shale. Soil reaction is moderately alkaline.

Gaynor soils have moderately slow permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of between 20 and 40 inches.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Gaynor silty clay loam, 1 to 3 percent slopes, located 1,850 feet south and 1,050 feet east of the northwest corner of sec. 23, T. 2 N., R. 69 W.:

A1—0 to 6 inches, light olive-brown (2.5Y 5/3) heavy silty clay loam, olive brown (2.5Y 4/3) when moist; strong, fine, granular structure; soft, very friable; calcareous; moderately alkaline; clear, smooth boundary.

AC—6 to 10 inches, light olive-brown (2.5Y 5/3) heavy silty clay loam, olive brown (2.5Y 4/3) when moist; weak, medium, subangular blocky structure; extremely hard, firm; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—10 to 30 inches, light yellowish-brown (2.5Y 6/3) heavy silty clay loam, light olive brown (2.5Y 5/3) when moist; massive; very hard, firm, plastic; calcareous with some discontinuous accumulation of secondary calcium carbonate and calcium sulfate as soft segregations and crystals; moderately alkaline; gradual, wavy boundary.

IIC2—30 to 60 inches, soft, calcareous silty shale.

The A horizon ranges from 4 to 8 inches in thickness. The C horizon ranges from silty clay loam to clay in texture. Depth to underlying shale or sandstone ranges from 20 to 40 inches.

Gaynor silty clay loam, 1 to 3 percent slopes (GaB).—This soil is mainly in the northeastern part of the Area. In most places it occurs as areas more than 6 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Samsil clay, 3 to 12 percent slopes; Colby silty clay loam, 1 to 3 percent slopes; and Gaynor silty clay loam, 3 to 9 percent slopes. These inclusions make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is slight to moderate.

All of the acreage of this soil is used for irrigated and dryland crops. (Capability units IVs–1, irrigated, and IVe–4, nonirrigated; tree suitability group 3)

Gaynor silty clay loam, 3 to 9 percent slopes (GaD).—This soil is in the northeastern part of the Area. In most places it occurs as areas more than 20 acres in size.

Included with this soil in mapping are small areas of Samsil clay, 3 to 12 percent slopes; Colby silty clay loam, 5 to 9 percent slopes; and Renohill silty clay loam, 3 to 9 percent slopes. Also included are a few small areas that have gravel spots. These included soils make up about 20 percent of each mapped area.

Runoff is rapid on this soil. The hazard of water erosion and soil blowing is high.

Almost all of the acreage of this soil is used for irrigated crops and for pasture. A few small areas are used for dryland crops. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Goldvale Series

The Goldvale series is made up of deep, well-drained soils that formed on mountainsides in loamy alluvium. Slopes are 9 to 55 percent. Elevations are 5,900 to 6,700 feet. The native vegetation is mainly ponderosa pine and Douglas-fir. Annual precipitation is 18 to 22 inches. Mean annual air temperature is 43° to 47° F., and the frost-free season is about 100 to 120 days.

In a representative profile the surface layer, about 2 inches thick, is grayish-brown stony coarse sandy loam mantled with forest litter and stones. The subsurface layer is pink coarse sandy loam about 17 inches thick. Below this is about 6 inches of pink or reddish-brown sandy clay loam and sandy loam. The subsoil is a reddish-brown stony sandy clay or stony sandy clay loam that extends to a depth of 65 inches or more and that has many stones. Soil reaction is slightly acid.

Goldvale soils have moderate permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for grazing, woodcutting, recreational purposes, and homesites.

Representative profile of Goldvale stony coarse sandy loam in Goldvale-Rock outcrop complex, 9 to 55 percent slopes, located 1,500 feet west and 2,340 feet north of the southeast corner of sec. 26, T. 2 N., R. 71 W.:

O1—4 to 2 inches, undecomposed organic material, chiefly needles, bark and twigs.

O2—2 inches to 0, partially decomposed organic material, chiefly needles, bark, and twigs.

A1—0 to 2 inches, grayish-brown (10YR 5/2) stony coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; strong, fine, crumb structure; soft, very friable; 20 percent flagstone; slightly acid; clear, smooth boundary.

A2—2 to 19 inches, pink (5YR 8/3) stony coarse sandy loam, light reddish brown (5YR 6/3) when moist; moderate, thick, platy structure that parts to moderate fine granular; slightly hard, very friable; 20 percent flagstone; slightly acid; gradual, wavy boundary.

A&B—19 to 25 inches, pink (5YR 8/3) stony light coarse sandy clay loam, light reddish brown (5YR 6/3) when moist; contains thin, discontinuous, reddish-brown (2.5YR 5/4) coarse sandy clay lamellae and nodules; lamellae are reddish brown (2.5YR 4/4) when moist; lamellae have thin, continuous clay films on ped faces; horizon has weak, medium, subangular blocky structure; very hard, very friable; 20 percent flagstone; slightly acid; clear, wavy boundary.

B2t—25 to 57 inches, reddish-brown (2.5YR 5/4) stony sandy clay, reddish brown (2.5YR 4/4) when moist; moderate, medium, subangular blocky structure; extremely hard, friable; thick, continuous clay films on faces of peds and inside root channels and pores; 20 percent flagstone; slightly acid; gradual, wavy boundary.

B3t—57 to 65 inches, reddish-brown (2.5YR 5/4) stony sandy clay loam, reddish brown (2.5YR 4/4) when moist; weak, coarse, subangular blocky structure; extremely hard, friable; patchy clay films on faces of peds and inside root channels; 25 percent flagstone; slightly acid; gradual, wavy boundary.

C—65 to 75 inches, light reddish-brown (2.5YR 6/4) stony coarse sandy loam, reddish brown (2.5YR 5/4) when moist; massive; very hard, very friable; 25 percent flagstone; slightly acid.

The A1 horizon ranges from 0 to 3 inches in thickness. The A2 horizon ranges from 8 to 20 inches in thickness and from loamy sand to sandy loam in texture. The B2 horizon ranges from clay to sandy clay in texture. Structure of the B2 horizon ranges from moderate to strong subangular blocky or blocky.

Goldvale-Rock outcrop complex, 9 to 55 percent slopes (GrF).—This complex is made up of about 55 percent Goldvale stony coarse sandy loam and about 30 percent Rock outcrop. This complex is on long mountain spurs and ridges in the western part of the Area. Goldvale soils are on the smoother west-facing slopes where there are trees. Rock outcrop is throughout the complex, but particularly on the ridgetops.

Included with this complex in mapping are minor amounts of shallow soils on ridgetops, and alluvial soils along the edges of streams and drainageways. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on areas of this complex. The erosion hazard is high.

All of the acreage of this complex is used for grazing livestock and for woodcutting. An increasing number of areas are used for homesites, recreational purposes, and wildlife habitat. (Capability unit VIIe–1, nonirrigated; tree suitability group 2)

Hargreave Series

The Hargreave series is made up of moderately deep, well-drained soils. These soils formed on uplands in loamy residuum weathered from sandstone. In local areas this material is being reworked by the wind. Slopes are 1 to 9 percent. Elevations are 4,900 to 5,500 feet. The vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 6 inches thick, is dark grayish-brown fine sandy loam. The upper part of the subsoil is brown sandy clay loam about 7 inches thick. The lower part is brown fine sandy loam about 7 inches thick. The substratum to a depth of about 27 inches is a brown fine sandy loam that overlies sandstone. In the surface layer and subsoil, soil reaction is neutral, and in the substratum, it is mildly alkaline.

Hargreave soils have moderate permeability. Available water capacity for the profile is low to moderate. Roots can penetrate to a depth of between 20 and 40 inches.

These soils are used mainly for both irrigated and nonirrigated pasture.

Representative profile of Hargreave fine sandy loam, 3 to 9 percent slopes, located 600 feet west and 2,000 feet north of the southeast corner of sec. 14, T. 1 S., R. 70 W.:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak and moderate, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B2t—6 to 13 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard, friable; nearly continuous clay films on ped faces; neutral; clear, smooth boundary.

B3t—13 to 20 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) when moist; weak, medium, prismatic structure that parts to weak, medium, subangular blocky; hard, very friable; patchy clay films on ped faces; neutral; clear, smooth boundary.

C1—20 to 27 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

C2—27 to 36 inches, variegated, partially weathered, fine sandstone.

The A1 horizon ranges from 4 to 8 inches in thickness. There is 0 to 15 percent gravel and cobbles on the surface in some places. The B2 horizon ranges from heavy fine sandy loam to sandy clay loam in texture. Depth to sandstone

ranges from 20 to 40 inches. In most areas these soils are noncalcareous, but in a few places they are faintly calcareous because of recharge by irrigation water.

Hargreave fine sandy loam, 1 to 3 percent slopes (HaB).—This soil is on the uplands, mainly in the south-central part of the Area. In most places it is in areas more than 10 acres in size. Many areas have scattered cobbles and gravel on the surface.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 8 inches of fine sandy loam.

Included with this soil in mapping are small areas of shallow soils that are less than 20 inches deep and small areas of sandstone outcrop less than 1 acre in size. These make up about 5 percent of each mapped area. In the eastern part of the Area is a Hargreave-like soil that has a lighter colored surface layer and is calcareous throughout the profile. This included soil resembling the Hargreave makes up about 10 percent of the acreage in those areas where it occurs.

Runoff is slow to medium on this soil. The erosion hazard is moderate.

All of the acreage of this soil is used for irrigated crops and pasture. Small grains and corn are the main crops. The remaining acreage is used for grass, but it can be dryfarmed. (Capability units IIIe–9, irrigated, and IIIe–8, nonirrigated; tree suitability group 4)

Hargreave fine sandy loam, 3 to 9 percent slopes (HaD).—This soil is on the uplands, mainly in the south-central part of the area. In most places it occurs as areas more than 10 acres in size. Many areas have scattered cobbles and gravel on the surface. This soil has the profile described as representative for the series.

Included with this soil in mapping are minor areas of Hargreave fine sandy loam, 1 to 3 percent slopes; areas of shallow soils; and sandstone outcrop. A few small wet spots are also included. These make up about 5 percent of each mapped area. In the eastern part of the survey area is a Hargreave-like soil that has a lighter colored surface layer and is calcareous throughout the profile. This included soil makes up about 15 percent of the mapped areas in which it occurs.

Runoff is medium to rapid on this soil. The erosion hazard is moderate to high.

About half of the acreage of this soil is used for irrigated crops or pasture. Small grains and corn are the main crops. The other half of the acreage is in grass. (Capability units IVe–2, irrigated, and VIe–2, nonirrigated; tree suitability group 4)

Heldt Series

The Heldt series is made up of deep, moderately well drained soils. These soils formed on terraces and uplands in loamy alluvium weathered from sedimentary rock. Slopes are 0 to 5 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 8 inches thick, is grayish-brown clay. The upper 12 inches of the subsoil is strongly calcareous, light olive-brown clay. The lower 16 inches is strongly calcareous, light yellowish-brown clay loam. The substratum to a depth of 60 inches or more is strongly calcareous, light yellowish-brown clay loam. Soil reaction is moderately alkaline.

Heldt soils have slow permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dry cropland, and for pasture. Where these soils are irrigated, water must be applied carefully to prevent waterlogging.

Representative profile of Heldt clay, 0 to 3 percent slopes, located 1,150 feet north and 900 feet east of the southwest corner of sec. 23, T. 2 N., R. 70 W.:

Ap—0 to 8 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, medium, granular; very hard, very firm; slightly calcareous; moderately alkaline; clear, smooth boundary.

B2—8 to 20 inches, light olive-brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) when moist; moderate, coarse and medium, angular blocky structure; extremely hard, very firm; strongly calcareous; moderately alkaline; gradual, smooth boundary.

B3—20 to 36 inches, light yellowish-brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) when moist; weak and moderate, medium, subangular blocky structure; hard, firm; many slickensides; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C—36 to 60 inches, light yellowish-brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) when moist; massive; hard, firm; strongly calcareous; moderately alkaline.

The AP horizon ranges from 4 to 10 inches in thickness. The B2 horizon ranges from clay loam to clay in texture. Structure of the B2 horizon is weak or moderate.

Heldt clay, 0 to 3 percent slopes (HeB).—This soil is mainly in the northeastern part of the Area. In most places it occurs as irregularly shaped areas more than 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Nunn clay loam, 1 to 3 percent slopes; Colby silty clay loam, 1 to 3 percent slopes; and Renohill silty clay loam, 1 to 3 percent slopes. These make up about 10 percent of each mapped area.

Runoff is medium to rapid on this soil. The erosion hazard is moderate. This soil takes in water slowly. It is difficult to work.

About two-thirds of the acreage of this soil is used for irrigated crops. The rest is used for dryland crops. (Capability units IIIe–1, irrigated, and IVe–4, nonirrigated; tree suitability group 6)

Heldt clay, 3 to 5 percent slopes (HeC).—This soil is mainly in the eastern part of the Area. In most places it occurs as irregularly shaped areas more than 15 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 6 inches of clay. In some areas near ridgetops, scattered gravel is on the surface. The subsoil is calcareous clay about 20 inches thick.

Included with this soil in mapping are small areas of Renohill silty clay loam, 3 to 9 percent slopes; and Colby silty clay loam, 3 to 5 percent slopes. Minor areas having slopes of 5 to 9 percent are also included. These inclusions make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high. This soil takes in water slowly. It is difficult to work.

About half of the acreage is used for irrigated crops, and the rest for dryland crops. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 6)

Juget Series

The Juget series is made up of shallow, somewhat excessively drained soils. These soils formed on mountain slopes and ridges in sandy residuum weathered from granite. Slopes are 9 to 55 percent. Elevations are 6,300 to 8,200 feet. At lower elevations the native vegetation is mainly ponderosa pine, and at higher elevations it is Engelmann spruce and Douglas-fir with an understory of grass. Annual precipitation is 18 to 24 inches. Mean annual air temperature is 43° to 46° F., and the frost-free season is about 80 to 120 days.

In a representative profile the surface layer, about 6 inches thick, is dark-gray very gravelly sandy loam. The underlying material, about 5 inches thick, is brown very gravelly loamy sand. Underlying this layer is granite. Soil reaction is slightly acid.

Juget soils have rapid permeability. Available water capacity for the profile is low. Roots can penetrate to a depth of less than 20 inches.

These soils are used mainly for grazing, although some areas with scattered trees are used for recreation, forestry, and homesites. The grass cover must be maintained to help prevent erosion.

Representative profile of Juget very gravelly sandy loam, in Juget-Rock outcrop complex, 9 to 55 percent slopes, located 2,540 feet north and 650 feet east of the southwest corner of sec. 11, T. 1 N., R. 71 W.:

A1—0 to 6 inches, dark-gray (10YR 4/1) very gravelly sandy loam, black (10YR 2/1) when moist; weak, very fine, granular structure; soft, very friable; 60 percent gravel and stone; slightly acid; clear, smooth boundary.

C—6 to 11 inches, brown (10YR 5/3) very gravelly loamy sand, dark grayish brown (10YR 4/2) when moist; massive; hard, friable; about 80 percent fine gravel; slightly acid; clear, wavy boundary.

R—11 inches, hard granite bedrock.

The A1 horizon ranges from 4 to 8 inches in thickness and from very gravelly sandy loam to very gravelly loamy sand in texture. Depth to bedrock ranges from 10 to 20 inches. The average rock fragment content of the soil ranges from 50 to 70 percent and is dominantly fine gravel.

Juget-Rock outcrop complex, 9 to 55 percent slopes (JrF).—This complex is made up of about 50 percent Juget very gravelly sandy loam and about 30 percent Rock outcrop. This complex is in the western part of the Area. The profile of the Juget soil in this complex is the one described as representative of the Juget series.

Included with this complex in mapping are small areas of Peyton soils near drainageways and a few small areas of Allens Park soils. These included soils make up about 20 percent of each mapped area.

Runoff is rapid on this complex. The erosion hazard is high. Juget soils take in water readily, but they retain only limited amounts for plant use because of their shallow depth to bedrock.

None of this complex is suitable for cultivation. It is in grass and scattered terees and shrubs. In the past, it was used for grazing livestock and for forestry, but now many areas are used for homesites, recreational purposes, and wildlife habitat. (Capability unit VIIs–1, nonirrigated; tree suitability group 2)

Kim Series

The Kim series is made up of deep, well-drained soils. These soils formed on terraces in calcareous, loamy alluvium. Slopes are 0 to 3 percent. Elevations are 4,900 to 5,500 feet. The native vegetation was mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 11 inches deep, is strongly calcareous, pale-brown clay loam. The underlying material is strongly calcareous, pale-brown and brown sandy clay loam and clay loam that reaches to a depth of 60 inches or more. Some soft lime segregations are in the upper part of this material. In the surface layer, soil reaction is mildly alkaline, and in the underlying material, it is moderately alkaline.

Kim soils have moderate permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used mainly for irrigated crops and are productive if well managed.

Representative profile of Kim clay loam in Nunn-Kim complex (0 to 3 percent slopes), located 900 feet north and 60 feet east of the southwest corner of sec. 9, T. 2 N., R. 69 W.:

Ap—0 to 11 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard, friable; strongly calcareous; mildly alkaline; clear, smooth boundary.

C1ca—11 to 31 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; hard, very friable; strongly calcareous with few, medium and coarse, white lime segregations; moderately alkaline; clear, smooth boundary.

C2ca—31 to 60 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; massive; hard, firm; strongly calcareous and contains concretions of calcium carbonate; moderately alkaline.

The A horizon ranges from 8 to 14 inches in thickness and from sandy clay loam to clay loam in texture.

In this survey area Kim soils are mapped only in association with Nunn soils.

Kutch Series

The Kutch series is made up of moderately deep, well-drained soils. These soils formed on uplands and valley sides in clayey residuum weathered from sedimentary rock. Slopes are 3 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short and mid grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 7 inches thick, is dark grayish-brown clay loam. The subsoil is brown clay about 15 inches thick. The substratum is calcareous, light brownish-gray clay about 8 inches

thick. Below this, at a depth of 30 inches, is shale. In the surface layer and subsoil, soil reaction is slightly acid, and in the underlying material, it is moderately alkaline.

Kutch soils have slow permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 20 to 40 inches.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Kutch clay loam, 3 to 9 percent slopes, located 2,340 feet east and 400 feet north of the southwest corner of sec. 11, T. 1 S., R 70 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, medium, granular; very hard, firm; slightly acid; clear, smooth boundary.

B2t—7 to 22 inches, brown (10YR 5/3) clay, dark brown (10YR 4/3) when moist; moderate, coarse, subangular blocky structure that parts to moderate, medium, angular blocky; extremely hard, firm; thin patchy clay films on aggregate faces; slightly acid; clear, smooth boundary.

C1ca—22 to 30 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; massive; extremely hard, very firm; calcareous; common, fine to coarse, prominent, white (10YR 8/2) soft masses of lime; moderately alkaline; gradual, smooth boundary.

C2—30 inches, gray calcareous shale.

The Ap horizon ranges from 6 to 12 inches in thickness and from clay loam to light clay in texture. The structure of the B2 horizon ranges from weak prismatic to moderate, coarse and medium, subangular blocky and blocky. Depth to shale ranges from 20 to 40 inches.

Kutch clay loam, 3 to 9 percent slopes (KuD).—This soil is on the uplands, mainly in the south-central part of the Area. In most places it is in areas more than 20 acres in size. In some places scattered gravel and cobblestones are on the surface.

Included with this soil in mapping are small areas of Nunn clay loam, 5 to 9 percent slopes; Samsil clay, 3 to 12 percent slopes; Renohill silty clay loam, 3 to 9 percent slopes; and Shingle loam. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

All of the acreage of this soil is used for irrigated and dryland crops and for native pasture. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Laporte Series

The Laporte series is made up of shallow, well-drained soils. These soils formed on upland ridges in loamy residuum derived from limestone and limy shale. Slopes are 5 to 20 percent. Elevations are 5,200 to 5,800. The native vegetation is mainly short and mid grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is strongly calcareous, grayish-brown very fine sandy loam about 8 inches thick. The underlying material is strongly calcareous, pale-brown loam, about 5 inches thick, that overlies limestone. Soil reaction is moderately alkaline.

Laporte soils have moderate permeability. Available water capacity for the profile is low. Roots can penetrate to a depth of between 10 to 20 inches.

These soils are used mainly for pasture or range, but in some areas the underlying limestone is used for the manufacture of cement.

Representative profile of Laporte very fine sandy loam, 5 to 20 percent slopes, located 1,820 feet west and 1,320 feet north of the southeast corner of sec. 16, T. 3 N., R. 70 W.:

A1—0 to 8 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure that parts to weak, fine, granular; soft, very friable; strongly calcareous; moderately alkaline; clear, wavy boundary.

C—8 to 13 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; soft, friable; strongly calcareous; moderately alkaline; clear, wavy boundary.

R—13 to 20 inches, gray limestone.

The A horizon ranges from 6 to 10 inches in thickness and from very fine sandy loam to loam in texture. Depths to limestone ranges from 10 to 20 inches. These soils are typically calcareous, but in some places are leached in the upper few inches. From 0 to 15 percent of the soil material is limestone chips.

Laporte very fine sandy loam, 5 to 20 percent slopes (LaE).—This soil is on tops and sides of ridges in the northwestern part of the Area. In most places it occurs as long, narrow areas more than 15 acres in size.

Included with this soil in mapping are some small areas of Manvel loam and near ridgetops, areas of Rock outcrop only a few feet wide. Also included is a Laporte-like soil that has limestone at depths below 20 to 40 inches. These included soils and Rock outcrop make up about 15 percent of each mapped area.

Runoff is medium to rapid on this soil. The erosion hazard is high. Available water capacity is low because of the depth to limestone.

This soil is too shallow to be cultivated. Almost all of the acreage is in range or pasture. (Capability unit VIe–3, nonirrigated; tree suitability group 6)

Longmont Series

The Longmont series is made up of deep, poorly drained, salty and alkaline soils. These soils formed on terraces and upland swales in clayey alluvium derived from shale. Slopes are 0 to 3 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly alkali sacaton and inland saltgrass. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is calcareous, light brownish-gray and light olive-brown clay about 21 inches thick. The underlying material is calcareous, light olive-brown and pale-olive clay to a depth of 60 inches or more. This material is mottled and has gypsum segregations. Soil reaction in the surface layer is strongly alkaline, and in the underlying material it is moderately alkaline.

Longmont soils have slow permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more and the seasonal high water table is between a depth of 2 and 4 feet.

These soils are used for pasture, homesites, and industrial sites.

Representative profile of Longmont clay, 0 to 3 percent slopes, located 500 feet north and 100 feet west of the south quarter of sec. 13, T. 2 N., R. 70 W.:

A11—0 to 5 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 4/2) when moist; weak, medium, subangular blocky structure; hard, firm; calcareous; strongly alkaline; clear, smooth boundary.

A12—5 to 21 inches, light olive-brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) when moist; weak, coarse, subangular blocky structure; extremely hard, very firm; calcareous; strongly alkaline; diffuse boundary.

C1csca—21 to 31 inches, light olive-brown (2.5Y 5/3) clay with many, medium, distinct yellowish-brown (10YR 5/4) mottles, dark grayish brown (2.5Y 4/3) when moist; massive; extremely hard, very firm; calcareous; common, fine to medium clusters of gypsum crystals and few, fine to medium, hard lime concretions; strongly alkaline; gradual, diffuse boundary.

C2cscag—31 to 60 inches, pale-olive (5Y 6/3) clay with common, medium, distinct olive (5Y 4/3) mottles, olive (5Y 5/3) when moist; massive; extremely hard, very firm; calcareous; common, fine to medium clusters of gypsum crystals and few to common, fine and medium, hard lime concretions; moderately alkaline.

The A1 horizon ranges from 12 to 24 inches in thickness and from clay loam to clay or silty clay in texture. The C horizon ranges from heavy clay loam to clay in texture. In most places shale is at a depth of more than 60 inches, but in a few areas it is between depths of 40 and 60 inches.

Longmont clay, 0 to 3 percent slopes (LoB).—This soil is in the eastern part of the Area. A few soil areas are somewhat concave. In most places this soil is in irregular areas more than 20 acres in size.

Included with this soil in mapping is a Longmont-like soil that has shale at a depth of less than 40 inches. Also included are small areas of Colby silty clay loam, wet, 0 to 3 percent slopes; and small areas of Heldt clay, 0 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

In most places runoff is slow, but some concave areas are ponded. The erosion hazard is slight. Drainage and removal of salt and alkali are difficult because this soil is slowly permeable.

Almost all of the acreage of this soil is in pasture, except for some areas that are urbanized. Efforts to establish better stands of grass have been partly successful. (Capability unit VIw–1, nonirrigated; tree suitability group 6)

Loveland Series

The Loveland series is made up of deep, somewhat poorly drained soils. These soils formed on terraces and bottom lands in loamy alluvium that overlies gravelly and sandy materials. Slopes are 0 to 1 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly bluegrass and blue grama. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is calcareous, dark grayish-brown light clay loam about 20 inches thick. It is mottled in the lower part. The underlying material, about 10 inches thick, is strongly calcareous, grayish-brown light clay loam that is mottled. Underlying this to a depth of 60 inches or more is mottled, light brownish-gray gravelly sand. In the surface layer and underlying material soil reaction is moderately alkaline, and in the substratum it is mildly alkaline. In most areas, gypsum crystals and soft lime segregations are present in some layers.

Loveland soils have moderate permeability. Available water capacity for the profile is moderate to high, depending upon the depth to very gravelly sand. Roots can penetrate to a depth of 60 inches or more, and the seasonal high water table is at a depth of 2 to 4 feet.

These soils are used for pasture and crops. In some areas they are a source of gravel for construction.

Representative profile of Loveland clay loam, 0 to 1 percent slopes, in an area of Loveland soils located 70 feet east and 2,310 feet south of the northwest corner of sec. 11, T. 2 N., R. 69 W.:

A11—0 to 11 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; soft, very friable; calcareous; moderately alkaline; clear, smooth boundary.

A12—11 to 20 inches, dark grayish-brown (10YR 4/2) light clay loam with common, medium, distinct yellowish-brown (10YR 5/4) mottles, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; hard, firm; calcareous; moderately alkaline; abrupt, smooth boundary.

C1csca—20 to 30 inches, grayish-brown (10YR 5/2) light clay loam with common, medium, distinct, yellowish-brown (10YR 5/4 and 6/6) mottles, dark grayish brown (10YR 4/2) when moist; massive; hard, friable; strongly calcareous; few to common, fine to medium clusters of gypsum crystals, and common, medium and coarse, soft white lime segregations; moderately alkaline; clear, wavy boundary.

IIC2—30 to 60 inches, light brownish-gray (10YR 6/2) very gravelly sand with many, medium, distinct, strong-brown (7.5YR 5/6) mottles, grayish brown (10YR 5/2) when moist; single grained; loose when dry and moist; mildly alkaline.

The A horizon ranges from 18 to 23 inches in thickness and from sandy clay loam to clay loam in texture. The C horizon ranges from loam to clay loam or sandy clay loam in texture. Depth to underlying sand or gravel ranges from 20 to 40 inches.

Loveland soils (0 to 1 percent slopes) (Lv).—These soils are on stream terraces and bottoms in the eastern part of the Area. In most places they are in irregular areas more than 20 acres in size.

The profile of these soils is similar to the one described as representative for the series, but the texture of the surface layer ranges from sandy clay loam to clay loam.

Included with these soils in mapping is a Loveland-like soil that has a lighter colored surface layer. Also included are gravel bars less than 1 acre in size, small areas of McClave clay loam, and areas of Niwot soils. These included soils and gravel bars make up about 15 percent of each mapped area.

Runoff is slow on these soils. The erosion hazard is slight.

All of the acreage of these soils is used for irrigated crops or pasture. (Capability unit IIIw–1, irrigated; tree suitability group 5)

Made Land

Made land (Ma) is on nearly level areas along St. Vrain Creek near the eastern edge of the Area. This land is

made up of areas formerly used as settling basins for waste materials from processing sugar beets. These areas are high in lime, nitrogen, and phosphate.

The largest areas of Made land have been partially reclaimed and seeded to tall wheatgrass. These areas are not suited for any other agricultural use and should remain in grass. Where seeding has been successful and a stand of grass has been established, Made land can be used for grazing or for production of hay. Areas that have not been reclaimed are bare of vegetation. (Capability units IVw–1, irrigated, and VIIIs–1, nonirrigated; not placed in a tree suitability group)

Manter Series

The Manter series is made up of deep, well-drained soils. These soils formed on terraces and uplands in loamy eolian and outwash materials. Slopes are 0 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is brown sandy loam about 6 inches thick. The subsoil, about 10 inches thick, is brown and pale-brown sandy loam. The substratum is strongly calcareous, very pale brown sandy loam and loamy sand that extends to a depth of 60 inches or more. In the surface layer and subsoil, soil reaction is neutral, and in the underlying material, it is moderately alkaline.

Manter soils have moderate permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Manter sandy loam, 1 to 3 percent slopes, located 400 feet west and 1,320 feet south of the northeast corner of sec. 19, T. 1 N., R. 69 W.:

Ap—0 to 6 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak, fine, crumb structure; soft, very friable; neutral; clear, smooth boundary.

B2t—6 to 11 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; weak, medium and coarse, subangular blocky structure; slightly hard, very friable; few, thin, patchy clay films on ped faces; neutral; clear, smooth boundary.

B3t—11 to 16 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; slightly hard, very friable; few, thin patchy clay films on ped faces; neutral; gradual, wavy boundary.

C1ca—16 to 34 inches, very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) when moist; massive; soft, very friable; strongly calcareous; few to common, medium, white (10YR 8/2), soft lime segregations; moderately alkaline; gradual, wavy boundary.

C2ca—34 to 60 inches, very pale brown (10YR 7/3) loamy sand, brown (10YR 5/3) when moist; massive; soft, very friable; strongly calcareous with few to common, medium, white (10YR 8/2) soft lime segregations; moderately alkaline.

The A horizon ranges from 6 to 12 inches in thickness. The B2t horizon ranges from light sandy loam to heavy sandy loam. Structure ranges from weak prismatic to moderate subangular blocky. Content of coarse fragments ranges from 0 to 15 percent.

Manter sandy loam, 0 to 1 percent slopes (MdA).—This soil is on stream terraces in the eastern part of the Area. In most places it is in areas more than 20 acres in size.

This soil has a profile much like the one described as representative for the series, but the surface layer is about 10 inches or sandy loam.

Included with this soil in mapping are a few areas of Manter sandy loam, 0 to 1 percent slopes, that have a water table at a depth of about 50 inches. Also included are small areas of Ascalon sandy loam, 0 to 1 percent slopes; and Calkins sandy loam, 0 to 1 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is slow on this soil. Water erosion is slight, and the hazard of soil blowing is moderate.

Almost all of the acreage of this soil is used for irrigated crops and pasture, but a few areas are used for dryland crops. (Capability units IIIe–4, irrigated, and IIIe–8, nonirrigated; tree suitability group 4)

Manter sandy loam, 1 to 3 percent slopes (MdB).—This soil is on terraces and uplands in the eastern part of the Area. In most places it is in areas more than 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Ascalon sandy loam, 1 to 3 percent slopes; Calkins sandy loam, 1 to 3 percent slopes; and Manter sandy loam, 0 to 1 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is slow to medium on this soil. The hazard of water erosion is moderate, and the hazard of soil blowing is high.

Almost all of the acreage of this soil is used for irrigated or dryland crops. (Capability units IIIe–4, irrigated, and IIIe–8, nonirrigated; tree suitability group 4)

Manter sandy loam, 3 to 9 percent slopes (MdD).—This soil is on terraces and on the uplands in the east-central part of the Area. In most places it occurs as irregularly shaped areas more than 15 acres in size.

Included with this soil in mapping are small areas of Manter sandy loam, 1 to 3 percent slopes; and Ascalon sandy loam, 3 to 5 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium to rapid on this soil. The erosion hazard is high.

All of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units IIIe–6, irrigated, and IVe–7, nonirrigated; tree suitability group 4)

Manvel Series

The Manvel series is made up of deep, well-drained soils. They formed on fans and smooth uplands in calcareous, loamy alluvium. Slopes are 1 to 3 percent. Elevations are 5,100 to 5,600 feet. The native vegetation is mainly short grasses. Annual precipitation is 14 to 17 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is strongly calcareous, grayish-brown loam about 6 inches thick. The underlying material is strongly calcareous, pale-brown

and yellowish-brown loam that extends to a depth of 60 inches or more. Soil reaction is moderately alkaline.

Manvel soils have moderate permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of a Manvel loam (1 to 3 percent slopes), located 400 feet west and 1,420 feet north of the southeast corner of sec. 16, T. 3 N., R. 70 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure that parts to weak, fine, crumb; soft, very friable; strongly calcareous; moderately alkaline; clear, smooth boundary.

C1—6 to 20 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, medium and fine, subangular blocky structure; slightly hard, friable; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2—20 to 60 inches, yellowish-brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard, friable; strongly calcareous; moderately alkaline.

The A horizon ranges from 6 to 12 inches in thickness and from loam to very fine sandy loam in texture. The C horizon is loam or silt loam in texture. Depth to bedrock is typically more than 60 inches, but in some places it is between depths of 40 and 60 inches.

Manvel loam (1 to 3 percent slopes) (Me).—This soil is in the north-central part of the Area. In most places it occurs as areas more than 30 acres in size.

Included with this soil in mapping is a Manvel-like soil that has limestone at a depth of less than 40 inches. Also included are a few small areas of Laporte very fine sandy loam, 5 to 20 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate.

All of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units IIe–1, irrigated, and IVe–4, nonirrigated; tree suitability group 3)

McClave Series

The McClave series is made up of deep, somewhat poorly drained soils. These soils formed on low terraces and bottom lands in loamy alluvium. Slopes are 0 to 1 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 40 inches thick, is dark grayish-brown and grayish-brown light clay loam that is mottled in the lower part. The underlying material is mottled, brown light clay loam that extends to a depth of 60 inches or more. Soil reaction is neutral.

McClave soils have moderate permeability. Available water capacity for the entire profile is high. Roots can penetrate to a depth of 60 inches or more, and the seasonal high water table is at a depth between 2 and 4 feet.

These soils are used for irrigated crops and pasture.

Representative profile of McClave clay loam, located 950 feet south and 60 feet west of the center of sec. 11, T. 2 N., R. 69 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) when moist; strong, medium, grannular structure; soft, very friable; neutral; clear, smooth boundary.

A12—7 to 19 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; hard, firm; neutral; gradual, wavy boundary.

A13g—19 to 40 inches, grayish-brown (10YR 5/2) light clay loam with many fine, distinct, brown (7.5YR 5/4) mottles; very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard, firm; neutral; gradual, wavy boundary.

C1g—40 to 60 inches, brown (10YR 5/3) light clay loam with many, large, distinct, brown (7.5YR 5/4) mottles; brown (10YR 4/3) when moist; massive, slightly hard, very friable; neutral.

The A horizon ranges from 25 to 40 inches in thickness. Mottles are present in the lower part of the A horizon. The C horizon is typically a light clay loam or loam, but in places it is sandy loam. Some areas are underlain by sand and gravel at a depth of more than 40 inches.

McClave clay loam (0 to 1 percent slopes) (Mm).—This soil is on stream terraces and bottoms in the eastern part of the Area. In most places it occurs as areas more than 20 acres in size.

Included with this soil in mapping are small areas of Calkins sandy loam, 0 to 1 percent slopes, and Loveland soils. Also included is a McClave-like soil that has a heavy clay loam surface layer less than 24 inches thick. In places, the surface layer is light colored, the subsoil is a heavy loam, and lime occurs throughout the profile. Included soils make up about 15 percent of each mapped area.

Runoff is slow on this soil. The erosion hazard is slight.

All of the acreage of this soil is used for irrigated crops. Some areas are used to produce vegetables. Some of those areas that have a water table between depths of 2 and 3 feet are used for irrigated pasture. (Capability unit IIw–1, irrigated; tree suitability group 5)

Nederland Series

The Nederland series is made up of deep, well-drained soils that formed on old high terraces and alluvial fans. The soils developed in loamy alluvium that contains many cobblestones and other stones. Slopes are 1 to 12 percent. Elevations are 5,500 to 6,500 feet. The native vegetation is mainly tall grasses and mid grasses. Annual precipitation is 15 to 20 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is brown very cobbly sandy loam about 4 inches thick. The subsoil, about 16 inches thick, is brown and reddish-brown, heavy coarse sandy loam and very cobbly sandy clay loam. Underlying these materials to a depth of 60 inches or more is reddish-brown very cobbly coarse sandy loam. Soil reaction is neutral.

Nederland soils have moderate permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used mostly for range, but some areas near the larger towns are used for homesites.

Representative profile of Nederland very cobbly sandy loam, 1 to 12 percent slopes, located 950 feet north of center of sec. 28, T. 1 S., R. 70 W.:

A1—0 to 4 inches, brown (7.5YR 5/2) very cobbly sandy loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; soft, very friable; 50 percent gravel and cobblestones; neutral; clear, smooth boundary.

B1t—4 to 7 inches, brown (7.5YR 5/3) very cobbly heavy coarse sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure that parts to moderate, fine, granular; hard, friable; few thin clay films on the faces of peds and as coatings on gravel and cobblestones; 50 percent gravel and cobbles; neutral; clear, smooth boundary.

B2t—7 to 15 inches, reddish-brown (5YR 5/3) very cobbly sandy clay loam, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; extremely hard, friable; many thin clay films on faces of peds, as coatings on sand and gravel fragments, and as bridges between sand grains; 50 percent gravel and cobblestones; neutral; gradual, wavy boundary.

B3t—15 to 20 inches, reddish-brown (2.5YR 5/4) very cobbly light sandy clay loam, reddish brown (2.5YR 4/4) when moist; weak, medium, subangular blocky structure; extremely hard, very friable; few thin clay films on the vertical faces of peds, as coatings on sand grains, and as bridges between sand grains; 60 percent cobblestones and gravel; neutral; gradual, wavy boundary.

C—20 to 60 inches, reddish-brown (2.5YR 5/4) very cobbly coarse sandy loam, reddish brown (2.5YR 4/4) when moist; massive; extremely hard, very friable; 60 percent cobbles and gravel; neutral.

The A horizon ranges from 3 to 6 inches in thickness. Content of rock fragments in the A and B horizons ranges from 50 to 70 percent. The C horizon ranges from light sandy clay loam to sandy loam in texture. Content of coarse fragments in the C horizon is more than 50 percent.

Nederland very cobbly sandy loam, 1 to 12 percent slopes (NdD).—This soil is on outwash fans and on the uplands in the central part of the Area. In most places it occurs as areas more than 50 acres in size. These areas have many stones and cobblestones on the surface.

Included with this soil in mapping are some soils that lack a sandy clay loam subsoil and that are very stony and cobbly sandy loam throughout the profile. Also included, near the eastern edge of outwash fans, are some small areas of Valmont cobbly clay loam, 1 to 5 percent slopes. The included soils make up about 20 percent of each mapped area.

Runoff is slow to medium on this soil. The erosion hazard is slight.

Most of the acreage of this soil is used for range or pasture. Many areas near Boulder are used as homesites. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Niwot Series

The Niwot series is made up of deep, somewhat poorly drained soils that are shallow over gravelly sand. These soils formed on low terraces and bottom lands in loamy alluvium superimposed over sand and gravel. Slopes are 0 to 1 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly bromegrass and water-tolerant grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is dark grayish-brown and grayish-brown clay loam and loam, about 14 inches thick, that is mottled in the lower part. The underlying material that extends to a depth of 60 inches or more is pale-brown gravelly sand that contains many mottles. In the surface layer, soil reaction is mildly alkaline, and below this, it is neutral.

Niwot soils have moderate permeability. Available water capacity for the profile is low to moderate. Roots can penetrate to a depth of 60 inches or more, and the seasonal high water table is at a depth of between 6 and 18 inches.

Most of this acreage is used for pasture. Some small areas are used for irrigated crops, and an increasing number of areas are used for sand and gravel pits.

Representative profile of Niwot clay loam in an area of Niwot soils that has slopes of 0 to 1 percent, located 2,100 feet south and 100 feet west of the center of sec. 10, T. 1 N., R. 69 W.:

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.

A12—6 to 14 inches, grayish-brown (10YR 5/2) loam with common, medium, distinct, strong-brown (7.5YR 5/6) mottles, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, fine, granular; slightly hard, soft, very friable; mildly alkaline; gradual, wavy boundary.

IIC—14 to 60 inches, pale-brown (10YR 6/3) gravelly sand with many, distinct, large, strong-brown (7.5YR 5/6) mottles, brown (10YR 5/3) when moist; single grain; loose dry or moist; neutral.

The A horizon ranges from 10 to 20 inches in thickness and from loam to sandy clay loam or clay loam in texture. Depth to underlying sand and gravel ranges from 10 to 20 inches.

Niwot soils (0 to 1 percent slopes) (Nh).—These soils are on stream terraces and bottoms in the eastern part of the Area. In most places they occur as irregularly shaped areas more than 30 acres in size.

The profile of these soils is much like the one described as representative for the series, but the surface layer is variable in texture. This layer ranges from sandy clay loam to light clay loam or loam.

Included with these soils in mapping are small, almost barren gravel bars and small areas of Lovelands soils. Also included are unnamed soils that are sandy. These included soils and gravel bars make up 15 percent of each mapped area.

Runoff is slow on these soils. The erosion hazard is slight except for back cutting near channels. Because of their position in the landscape, these soils are frequently flooded. They have a seasonal high water table.

Because of the high water table and the depth to sand or gravel, these soils are best suited for use as pasture or meadow. These soils are also suitable as a site for gravel pits. In some places a few small areas are used for irrigated crops. These are areas that are more convenient to farm than to plant to grass. (Capability units IVw–1, irrigated, and VIw–2, nonirrigated; tree suitability group 6)

Nunn Series

The Nunn series is made up of deep, well-drained soils. These soils formed on terraces and valley side slopes in loamy alluvium. Slopes are 0 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short and mid grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is grayish-brown clay loam about 10 inches thick. The subsoil, about 20 inches thick, is brown and very pale brown clay that grades to clay loam. It is noncalcareous in the upper part, but contains soft lime segregations in the lower part. The substratum is strongly calcareous, very pale brown clay loam extending to a depth of 60 inches or more. In the surface layer, soil reaction is neutral. In the upper part of the subsoil, it is mildly alkaline, and in the lower part of the subsoil and in the substratum it is moderately alkaline.

Nunn soils have slow and moderately slow permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

The acreage of these soils is used mainly for irrigated and dryland crops and for pasture.

Representative profile of Nunn clay loam, 0 to 1 percent slopes, located 1,320 feet east and 1,000 feet north of center of sec. 7, T. 2 N., R. 69 W.:

Ap—0 to 10 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure that parts to weak, fine, granular; hard, firm; neutral; clear, smooth boundary.

B21t—10 to 18 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that parts to strong, medium and fine, angular and subangular blocky; very hard, very firm; thin, continuous clay films on ped faces; mildly alkaline; clear, wavy boundary.

B22tca—18 to 23 inches, brown (10YR 5/3) clay, brown (10YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; very hard, very firm; thin, nearly continuous clay films on ped faces; strongly calcareous, with few, fine and medium, prominent, white (10YR 8/2) lime segregations; moderately alkaline; clear, wavy boundary.

B3tca—23 to 30 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure that parts to moderate, medium, subangular blocky; hard, firm; few, patchy clay films on ped faces; strongly calcareous, with few, fine and medium, prominent, white (10YR 8/2) lime segregations; moderately alkaline; gradual, wavy boundary.

Cca—30 to 60 inches, very pale brown (10YR 7/4) clay loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable; strongly calcareous; moderately alkaline.

The A horizon ranges from 6 to 14 inches in thickness and from sandy clay loam to clay loam in texture. The B2t horizon ranges from 4 to 15 inches in thickness and from heavy clay loam to clay in texture. Depth to calcium carbonate accumulation ranges from 14 to 30 inches. The C horizon ranges from heavy loam to clay loam in texture. Typically the sand and gravel substratum is below a depth of 60 inches, but in places it is between depths of 40 and 60 inches. As a result of excessive irrigation in some areas, a water table is present at a depth of between 3 and 5 feet.

Nunn sandy clay loam, 0 to 1 percent slopes (NnA).—This soil is throughout the eastern part of the Area. It occurs as irregularly shaped areas more than 30 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 10 inches of sandy clay loam. The subsoil is about 6 inches of clay underlain by about 22 inches of calcareous clay loam.

Included with this soil in mapping are small areas of Nunn clay loam, 0 to 1 percent slopes; Ascalon sandy loam, 0 to 1 percent slopes; and Kim soils. These included soils make up about 10 percent of each mapped area.

Runoff is slow on this soil. Permeability is moderately slow. Although the erosion hazard is slight, this soil should be protected from soil blowing during periods of strong winds.

Almost all of the acreage of this soil is used for irrigated crops. A few areas are used for irrigated pasture. (Capability unit I, irrigated; tree suitability group 3)

Nunn sandy clay loam, 1 to 3 percent slopes (NnB).—This soil is in the eastern part of the Area. In most places it occurs as irregularly shaped areas more than 20 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 10 inches of sandy clay loam. The subsoil is about 4 inches of clay underlain by about 20 inches of calcareous clay loam.

Included with this soil in mapping are some small areas of Kim soils; Nunn clay loam, 1 to 3 percent slopes; Ascalon sandy loam, 1 to 3 percent slopes; and Weld fine sandy loam, 1 to 3 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. Permeability is moderately slow. The erosion hazard is moderate.

Almost all of the acreage of this soil is used for irrigated crops, but a few small areas are used for irrigated pastures. (Capability unit IIe–2, irrigated; tree suitability group 3)

Nunn clay loam, 0 to 1 percent slopes (NuA).—This soil is in the eastern part of the Area. In most places it is in irregular areas more than 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Nunn sandy clay loam, 0 to 1 percent slopes; and Nunn clay loam, 1 to 3 percent slopes. Also included are a few small areas of Nunn clay loam, 0 to 1 percent slopes, that have a seasonal high water table. These included soils make up about 15 percent of each mapped area.

Runoff is slow on this soil. Permeability is slow. The erosion hazard is slight.

Almost all of the acreage of this soil is used for irrigated crops, but a few small areas are used for irrigated pasture. (Capability unit IIs–1, irrigated; tree suitability group 3)

Nunn clay loam, 1 to 3 percent slopes (NuB).—This soil is in the eastern part of the Area. In most places it occurs as irregularly shaped areas more than 40 acres in size.

Included with this soil in mapping are small areas of Kim soils; Nunn sandy clay loam, 1 to 3 percent slopes; Nunn clay loam, 0 to 1 percent slopes; and Valmont clay loam, 1 to 3 percent slopes. Also included near drainageways are small wet areas and a few areas

that have scattered gravel and cobbles on the surface. These included soils make up about 20 percent of each mapped area.

Runoff is medium on this soil. Permeability is slow. The erosion hazard is moderate.

Most of the acreage of this soil is used for irrigated crops and pasture, and the rest is used for dryland crops. A few very small areas are used for range. (Capability units IIe–1, irrigated, and IIIs–1, nonirrigated; tree suitability group 3)

Nunn clay loam, 3 to 5 percent slopes (NuC).—This soil is in the central part of the Area. In most places it occurs as areas more than 20 acres in size. In a few places this soil has scattered gravel and cobblestones on the surface.

The profile of this soil is much like the one described as representative for the series, but the subsoil is about 12 inches of clay. Lime is at a depth of about 16 inches.

Included with this soil in mapping are a few areas of a Nunn-like soil that has shale between depths of 40 and 60 inches. Also included are a few small areas of Kim soils and small areas of Nunn clay loam, 1 to 3 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The permeability of the subsoil is slow. The erosion hazard is moderate.

Most of the acreage of this soil is used for irrigated and dryland crops and for pasture. Some areas near Longmont are being converted to urban uses. (Capability units IIIe–2, irrigated, and IIIe–7, nonirrigated; tree suitability group 3)

Nunn clay loam, 5 to 9 percent slopes (NuD).—This soil is in the central part of the Area. Most areas are more than 20 acres in size and are irregularly shaped. In a few small places this soil has gravel and cobblestones on the surface.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 8 inches of clay loam. The subsoil is about 6 inches of noncalcareous clay underlain with about 24 inches of calcareous clay loam.

Included with this soil in mapping are some areas of a Nunn-like soil that has shale or sandstone between depths of 40 to 60 inches. Also included are small areas of Kim soils; small areas of Nunn clay loam, 3 to 5 percent slopes; and a few small areas of Kutch clay loam, 3 to 9 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The permeability of the subsoil is slow. The erosion hazard is high.

Most of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Nunn-Kim complex (0 to 3 percent slopes) (Nv).—This complex is in the eastern part of the Area. This complex consists of about 50 percent Nunn soils and about 35 percent Kim soils. Nunn soils are on the smoother parts of the complex. Kim soils are on the less smooth parts, or they are where extensive land leveling has been performed.

Nunn soils have a profile much like the one described as representative for the series, but in some places the surface layer is a sandy clay loam.

Kim soils have a profile much like that described as representative for the series, but in some places the surface layer is a sandy clay loam.

Included with this complex in mapping are areas of a soil having a surface layer that is thicker or thinner as a result of leveling. Also included are small wet areas that have a water table between depths of 3 and 5 feet. These included soils amount to about 15 percent of each mapped area.

Runoff is medium on this complex. The erosion hazard is moderate.

This complex is used for irrigated crops and pasture. (Capability unit IIe–1, irrigated; tree suitability group 3)

Otero Series

The Otero series is made up of deep, well-drained soils. These soils formed on terraces, rolling uplands, and valley side slopes in loamy alluvium and wind-laid materials. Slopes are 0 to 20 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly mid and tall grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 6 inches thick, is strongly calcareous, brown sandy loam. Below this is pale-brown sandy loam about 6 inches thick. The underlying material is strongly calcareous, light yellowish-brown sandy loam that extends to a depth of 60 inches or more. The upper part of the underlying material contains some soft lime segregations. Soil reaction is moderately alkaline.

Otero soils have moderately rapid permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Otero sandy loam in Ascalon-Otero complex, 9 to 20 percent slopes, located 1,300 feet west and 550 feet north of the southeast corner of sec. 9, T. 1 N., R. 69 W.:

Ap—0 to 6 inches, brown (10YR 5/3) sandy loam, brown (10YR 4/3) when moist; weak, fine, crumb structure; soft, very friable; strongly calcareous; moderately alkaline; clear, smooth boundary.

AC—6 to 12 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, very friable; strongly calcareous with few, fine and medium, prominent, white (10YR 8/2), soft lime segregations; moderately alkaline; clear, smooth boundary.

C1—12 to 36 inches, light yellowish-brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) when moist; weak, medium, subangular blocky structure; hard, very friable; strongly calcareous; moderately alkaline; clear, smooth boundary.

C2—36 to 60 inches, light yellowish-brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) when moist; massive; hard, very friable; strongly calcareous; moderately alkaline.

The A horizon ranges from 6 to 14 inches in thickness. The structure ranges from granular or crumb to weak subangular blocky. In most places the C horizon is sandy loam or fine sandy loam. Depth to bedrock is more than 60 inches, but in some places it is between depths of 40 and 60 inches. These soils are calcareous throughout the profile, although the

surface layer may be leached an inch or two down from the surface.

Otero soils are mapped only with Ascalon soils in this survey area.

Peyton Series

The Peyton series is made up of deep, well-drained soils. These soils formed on upland hills and valley side slopes in weathered loamy and sandy material that has been locally transported. Slopes are 5 to 20 percent. Elevations are 5,800 to 7,500 feet. The vegetation is mainly tall grasses and, in places, ponderosa pine. Annual precipitation is 18 to 24 inches. Mean annual air temperature is 44° to 48° F., and the frost-free season is about 80 to 120 days.

In a representative profile the surface layer is dark-gray very gravelly loamy sand about 11 inches thick. The subsoil, about 32 inches thick, is brown gravelly sandy clay loam that grades to gravelly coarse sandy loam. The substratum extending to a depth of 60 inches or more is pale-brown gravelly sandy loam. Soil reaction is neutral.

Peyton soils have moderate permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 40 to 60 inches or more.

These soils are used for pasture and homesites.

Representative profile of Peyton very gravelly loamy sand in an area of Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes, located 1,640 feet north and 100 feet east of southwest corner of sec. 11, T. 1 N., R. 71 W.:

A1—0 to 11 inches, dark-gray (10YR 4/1) very gravelly loamy sand, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B1t—11 to 16 inches, brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard, very friable; thin, patchy clay films on ped faces; neutral; clear, smooth boundary.

B2t—16 to 30 inches, brown (10YR 5/3) gravelly sandy clay loam, brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; very hard, friable; thin, nearly continuous clay films on ped faces; neutral; clear, smooth boundary.

B3t—30 to 43 inches, brown (10YR 5/3) gravelly coarse sandy loam, brown (10YR 4/3) when moist; weak, medium and coarse, subangular blocky structure; hard, friable; thin, patchy clay films on ped faces; neutral; gradual, smooth boundary.

C—43 to 60 inches, pale-brown (10YR 6/3) gravelly sandy loam, brown (10YR 5/3) when moist; massive; very hard, friable; neutral.

The A horizon ranges from 6 to 12 inches in thickness and from heavy loamy sand to sandy loam in texture. Structure of the B2 horizon ranges from weak and moderate subangular blocky to weak prismatic. The C horizon ranges from sandy loam to loamy sand in texture. Amount of coarse fragments in the soil ranges from 10 to 25 percent, although in places the surface layer contains up to 60 percent coarse fragments.

Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes (PgE).—This complex is on the uplands in the western part of the Area. These are open parklike areas mainly more than 20 acres in size. This complex consists of about 65 percent Peyton very gravelly loamy sand and about 20 percent Juget very gravelly loamy sand. Peyton very gravelly loamy sand is in the main part of the area. Juget very gravelly loamy sand is around the edges of the areas and on narrow ridges extending into the areas. The Peyton soil has the profile described as representative for the Peyton series. The Juget soil has a profile much like that described as representative for the Juget series, but the surface layer is very gravelly loamy sand.

Included with this complex in mapping are small areas of Rock outcrop and a few small areas of Allens Park soils. Also included along some drainageways are areas of a deep, dark-colored soil formed in alluvium. A few small areas around lakes or ditches have a seasonal high water table. The included soils make up about 15 percent of each mapped area.

Runoff is slow to medium on this complex. The erosion hazard is moderate to high. Tillage of most areas is limited by the amount of gravel.

All the acreage of this complex is used for pasture, recreational uses, and wildlife habitat. Some areas are used for homesites. (Capability unit VIIs–1, nonirrigated; tree suitability group 2)

Pinata Series

The Pinata series is made up of moderately deep, well-drained soils that formed on upland ridges and side slopes. These soils developed in stony sandy to clayey residuum and colluvium weathered from sandstone and shale. Slopes are 5 to 55 percent. Elevations are 6,000 to 7,000 feet. The native vegetation is mainly ponderosa pine with a sparse understory of grass. Annual precipitation is 14 to 18 inches. Mean annual air temperature is 47° to 51° F., and the frost-free season is about 100 to 130 days.

In a representative profile (fig. 3) the surface layer is brown very stony loamy fine sand about 3 inches thick. The subsurface layer, about 9 inches thick, is pink very stony loamy fine sand. The subsoil is a red very stony clay, about 20 inches thick, that overlies sandstone. Soil reaction is slightly acid.

Pinata soils have slow permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of between 20 and 40 inches.

These soils are used mainly for pasture and as a source of quarried sandstone. Some areas have a limited use for forestry.

Representative profile of Pinata very stony loamy fine sand in an area of Pinata-Rock outcrop complex, 5 to 55 percent slopes, located 1,200 feet east and 400 feet south of the northwest corner of sec. 6, T. 3 N., R. 70 W.:

O1—2 inches to 0, partially decayed pine needles and forest litter.

A1—0 to 3 inches, brown (7.5YR 5/2) very stony loamy fine sand, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

A2—3 to 12 inches, pink (5YR 7/3) very stony loamy fine sand, reddish brown (5YR 5/3) when moist; weak, coarse, subangular blocky structure; soft, very friable; slightly acid; abrupt, wavy boundary.

B2t—12 to 32 inches, red (2.5YR 5/6) very stony clay, dark red (2.5YR 3/6) when moist; weak, medium, prismatic structure that parts to moderate, coarse and medium, subangular blocky structure; very hard, firm; thick, continuous clay films on ped faces; slightly acid; clear, smooth boundary.

R—32 to 60 inches, reddish-brown (2.5YR 5/4) noncalcareous Lyons sandstone with flagstone cleavage.

The A1 horizon ranges from 0 to 4 inches in thickness, and the A2 horizon ranges from 7 to 18 inches in thickness The A horizon ranges from loamy fine sand to heavy loamy sand in texture. The B2t horizon ranges from 14 to 24 inches in thickness and from heavy clay loam to clay in texture. Amount of stones ranges from 35 to 80 percent throughout the profile.

Pinata-Rock outcrop complex, 5 to 55 percent slopes (PrF).—This complex is on upland ridges in the northwestern part of the Area. It is about 45 percent Pinata very stony loamy fine sand and about 35 percent Rock outcrop. The Pinata soil is throughout the area but mainly has the smoother slopes. Rock outcrop is scattered throughout the area, but mainly has the steeper slopes.

Mapped with this complex along drainageways are small areas of a Pinata-like soil that overlies sandstone at a depth of more than 40 inches. Near ridgetops are some soils that overlie sandstone at a depth of less than 20 inches. A few areas of Colluvial land are also included. These included soils and Colluvial land make up about 20 percent of each mapped area.

Runoff is medium to rapid on areas of this complex. The erosion hazard is high.

Most of the acreage of this complex is used for forestry and limited grazing of livestock. A major use in recent years is for quarrying of building stone. (Capability unit VIIe–1, nonirrigated; tree suitability group 6)

Renohill Series

The Renohill series is made up of moderately deep, well-drained soils. These soils formed on upland hills and ridges in loamy parent material weathered from shale and sandstone. Slopes are 1 to 9 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly

Figure 3.—**Profile of Pinata very stony loamy fine sand in an area of Pinata-Rock outcrop complex, 5 to 55 percent slopes.**

short and mid grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is slightly calcareous, light olive-brown silty clay loam about 7 inches thick. The subsoil, about 23 inches thick, is light olive-brown and light yellowish-brown silty clay and silty clay loam that is slightly calcareous in the upper part and strongly calcareous in the lower part. Calcareous weathered shale underlies the subsoil. In the surface layer and the upper part of the subsoil, soil reaction is mildly alkaline, and in the lower part of the subsoil, it is moderately alkaline.

Renohill soils have slow permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth between 20 and 40 inches.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Renohill silty clay loam, 3 to 9 percent slopes, located 50 feet north and 1,240 feet east of the southwest corner of sec. 3, T. 3 N., R. 69 W.:

Ap—0 to 7 inches, light olive-brown (2.5Y 5/4) silty clay loam, olive brown (2.5Y 4/4) when moist; moderate, medium, subangular blocky structure; soft, friable; slightly calcareous; mildly alkaline; clear, smooth boundary.

B21t—7 to 12 inches, light olive-brown (2.5Y 5/4) silty clay, olive brown (2.5YR 4/4) when moist; moderate, medium, prismatic structure that parts to moderate and strong, angular blocky; very firm, very hard; nearly continuous clay films on ped faces; slightly calcareous; mildly alkaline; clear, smooth boundary.

B22t—12 to 20 inches, light olive-brown (2.5Y 5/4) silty clay loam, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure that parts to moderate, medium and fine, angular blocky; very hard, very firm; nearly continuous clay films on ped faces; strongly calcareous; moderately alkaline; gradual, wavy boundary.

B3tca—20 to 30 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; very hard, firm; thin, patchy clay films on ped faces; strongly calcareous; moderately alkaline.

C—30 to 60 inches +, weathered calcareous shale.

The A horizon ranges from 6 to 12 inches in thickness and from loam to silty clay loam in texture. The B horizon ranges from silty clay loam to clay or silty clay in texture. Depth to underlying shale or sandstone ranges from 10 to 40 inches. The shallow depth to bedrock of Renohill loam is not typical of the Renohill series, but use and management of this shallow soil is similar to that for other Renohill soils having comparable slopes.

Renohill loam, 3 to 9 percent slopes (ReD).—This soil is on the uplands, mainly in the west-central part of the Area. In most places it is in irregular areas larger than 100 acres.

This soil has a profile similar to the one described as representative for the series, but the surface layer is a loam that is 3 to 5 inches thick. Hard sandstone is at a depth between 10 and 20 inches. This depth is somewhat shallower than is normal for Renohill soils as they occur in other areas. Because of its limited acreage and similar nonirrigated use and management, this soil has been named Renohill.

Included with this soil in mapping are a few areas of Rock outcrop. Also included are small areas of Samsil soils and Shingle soils that in most places are on the steeper west slopes. These included soils make about 20 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

This soil is unsuited to cultivation. Most of the acreage is in native range. In recent years some areas have been used as sites for small industry. (Capability unit VIe–3, nonirrigated; tree suitability group 6)

Renohill silty clay loam, 1 to 3 percent slopes (RnB).—This soil is mainly in the northeastern part of the Area. In most places it is in long, relatively narrow areas more than 15 acres in size.

The profile of this soil is like the one described as representative for the series, but the surface layer is about 9 inches of silty clay loam. The subsoil is about 23 inches thick and is a silty clay throughout.

Included with this soil in mapping are small areas of Gaynor silty clay loam, 1 to 3 percent slopes; Samsil clay, 3 to 12 percent slopes; and Heldt clay, 0 to 3 percent slopes. These inclusions make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate.

Almost all of the acreage of this soil is cultivated and is used for irrigated crops and pasture. The rest is used for dryland crops. A few small areas are used as pasture. (Capability units IVs–1, irrigated, and IVe–4, nonirrigated; tree suitability group 3)

Renohill silty clay loam, 3 to 9 percent slopes (RnD).—This soil is on the uplands, mainly in the northeastern part of the Area. In most places it is in long, relatively narrow areas more than 15 acres in size. In a few places this soil has scattered narrow areas more than 15 acres in size. In a few places this soil has scattered gravel and cobbles on the surface. This soil has the profile described as typical for the series.

Included with this soil in mapping are small areas of Gaynor silty clay loam, 3 to 9 pecent slopes; Samsil clay, 3 to 12 percent slopes; and Renohill silty clay loam, 1 to 3 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

All of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units IVe–1, irrigated, and VIe–1, nonirrigated; tree suitability group 3)

Rock Outcrop

Rock outcrop (Ro) consists mainly of steep slopes and cliffs in the western part of the Area. A few small areas of Rock outcrop are in the eastern part.

These barren areas are predominantly exposed bedrock that consists of mixed materials, including granite, sandstone, shale, and limestone.

Included in mapping are areas of a shallow soil that has less slope and is in areas of mixed colluvium near the bottom of slopes.

Rock outcrop is used mainly for watershed and wildlife habitat. Many areas are also used for such recreational purposes as climbing and hiking. (Capability unit VIIIs–1 nonirrigated; not placed in a tree suitability group)

Samsil Series

The Samsil series is made up of shallow, well-drained soils. These soils formed on upland hills and ridges in clayey residuum weathered from shale. Slopes are 3 to 25 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is strongly calcareous, light brownish-gray clay about 3 inches thick. The underlying material, about 9 inches thick, is strongly calcareous, light yellowish-brown clay. Underlying this is strongly calcareous shale. In the surface layer, soil reaction is mildly alkaline, and in the underlying material, it is moderately alkaline.

Samsil soils have slow permeability. Available water capacity for the profile is low. Roots can penetrate to a depth between 10 and 20 inches.

These soils are used mainly for dry pasture.

Representative profile of Samsil clay, 3 to 12 percent slopes, located 1,220 feet south and 400 feet east of center of sec. 14, T. 2 N., R. 70 W.:

A1—0 to 3 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, very fine, granular structure; hard, friable; strongly calcareous; mildly alkaline; clear, smooth boundary.

C1—3 to 12 inches, light yellowish-brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) when moist; weak, fine, subangular blocky structure; hard, firm; strongly calcareous with few, fine and medium clusters of gypsum; moderately alkaline; clear, smooth boundary.

C2—12 to 24 inches, partially weathered, strongly calcareous clay shale.

The A horizon ranges from 3 to 8 inches in thickness and from silty clay loam to silty clay or clay in texture. Depth to shale ranges from 10 to 20 inches.

Samsil clay, 3 to 12 percent slopes (SaD).—This soil is mainly on the uplands in the north-central part of the Area. In most places it is in areas more than 15 acres in size. In places this soil has scattered gravel and cobbles on the surface. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of shale outcrop, a few areas of Shingle loam, and a few small areas of Renohill silty clay loam, 3 to 9 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

This soil is best suited to pasture and is used for dry pasture. (Capability unit VIe–3, nonirrigated; tree suitability group 6)

Samsil-Shingle complex, 5 to 25 percent slopes (SeE).—This complex is made up of about 40 percent Samsil clay and about 40 percent Shingle soils. This complex is in the uplands, mainly in the southeastern part of the Area. These soils are intermingled, and their location depends upon the type of parent material from which they formed.

Samsil clay has a profile like the one described as representative for the series.

Shingle soils have a profile much like the one described as representative of the Shingle series, but in some places the surface layer is silty clay loam or loam.

Included with this complex in mapping are small areas of Renohill silty clay loam, 3 to 9 percent slopes; small areas of Gaynor silty clay loam, 3 to 9 percent slopes; and some areas of Kutch clay loam, 3 to 9 percent slopes. Also included along some gullies are outcrops of shale or sandstone. The included soils and the outcrops make up about 20 percent of each mapped area.

Runoff is rapid on this complex. The erosion hazard is high.

Soils of this complex are best suited to pasture. Most of the acreage is used for pasture or range. A few small areas are used for dryland crops. (Capability unit VIe–3, nonirrigated; tree suitability group 6)

Shingle Series

The Shingle series is made up of shallow, well-drained soils. These soils formed on upland hills and ridges in calcareous loamy residuum weathered from shale or sandstone. Slopes are 3 to 25 percent. Elevations are 4,900 to 5.500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to 18 inches. Mean annual temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is strongly calcareous, pale-brown loam about 4 inches thick. Below this is light yellowish brown loam about 3 inches thick. The underlying material, about 6 inches thick, is strongly calcareous, brownish-yellow loam. Underlying this is weathered shale and sandstone. In the surface layer, reaction is mildly alkaline, and with increasing depth, it becomes moderately alkaline.

Shingle soils have moderate permeability. Available water capacity for the profile is low. Roots can penetrate to a depth between 10 and 20 inches.

These soils are used for dryland crops and for pasture.

Representative profile of Shingle loam in Samsil-Shingle complex, 5 to 25 percent slopes, located 1,320 feet north of the southwest corner of sec. 13, T. 1 S., R. 69 W.:

A1—0 to 4 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) when moist; moderate, very fine, granular structure; soft, very friable; strongly calcareous; mildly alkaline; clear, smooth boundary.

AC—4 to 7 inches, light yellowish-brown (10YR 6/4) loam, yellowish brown (10YR 5/4) when moist; weak, medium, subangular blocky structure; slightly hard, very friable; strongly calcareous; mildly alkaline; clear, smooth boundary.

C1—7 to 13 inches, brownish-yellow (10YR 6/5) loam; yellowish brown (10YR 5/5) when moist; weak, medium, subangular blocky structure; slightly hard, friable; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2—13 to 20 inches, variegated, partially weathered shale and fine-grained sandstone.

The A horizon ranges from 4 to 8 inches in thickness and from loam or silt loam to light clay loam in texture. Where the C horizon is present, it ranges from 4 to 12 inches in thickness and from loam to silt loam in texture. Depth to bedrock ranges from 10 to 20 inches.

Shingle-Caynor complex, 3 to 20 percent slopes (SgE).—This complex consists of about 50 percent Shingle

soils and 35 percent Gaynor soils. The complex is on the uplands, mainly in the northeastern part of the Area. Most areas are more than 20 acres in size and are irregular in shape. Shingle soils are near ridgetops and on steeper slopes. In most places Gaynor soils are near the base of slopes.

Included with this complex in mapping are areas of Renohill silty clay loam, 3 to 9 percent slopes; Colby silty clay loam, 5 to 9 percent slopes; and Samsil clay, 3 to 12 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this complex. The erosion hazard is high.

This complex is best suited to pasture. Because the soils are shallow over bedrock, they are used for dryland crops and pasture. (Capability unit VIe–3, nonirrigated; tree suitability group 6)

Sixmile Series

The Sixmile series is made up of moderately deep, well-drained soils. These soils formed on upland ridges and side slopes in calcareous loamy residuum weathered from shale. Slopes are 10 to 50 percent. Elevations are 5,800 to 6,600 feet. The native vegetation is mainly mid grasses. Annual precipitation is 14 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 120 to 140 days.

In a representative profile the surface layer, about 4 inches thick, is strongly calcareous, reddish-brown stony loam. The underlying material is gray and reddish-gray light clay loam about 26 inches thick. Underlying this is weathered shale. Soil reaction is moderately alkaline.

Sixmile soils have moderate permeability. Available water capacity for the profile is moderate to high. Roots can penetrate to a depth between 20 and 40 inches.

These soils are used for grazing.

Representative profile of Sixmile stony loam, 10 to 50 percent slopes, located 650 feet west and 1,000 feet north of the southeast corner of sec. 8, T. 3 N., R. 70 W.:

A1—0 to 4 inches, dark reddish-gray (5YR 4/2) stony loam, dark reddish brown (5YR 3/2) when moist; moderate, fine, granular structure; soft, very friable; many stones and boulders; strongly calcareous; moderately alkaline; gradual, wavy boundary.

C1—4 to 20 inches, gray (5YR 6/1) light clay loam, dark gray (5YR 4/1) when moist; massive; hard, very friable; strongly calcareous; moderately alkaline; gradual, wavy boundary.

C2—20 to 30 inches, reddish-gray (10YR 5/1) light clay loam, dark reddish gray (10YR 4/1) when moist; massive; hard, very friable; strongly calcareous; moderately alkaline; gradual, wavy boundary.

C3—30 to 60 inches, reddish-gray (10YR 5/1) partially disintegrated shale.

The A horizon ranges from 3 to 6 inches in thickness and from loam to light clay loam in texture. The C horizon ranges from loam to clay loam in texture. Depth to bedrock ranges from 20 to 40 inches.

Sixmile stony loam, 10 to 50 percent slopes (SmF).—This soil is on the uplands on the western side of steep ridges in the western part of the Area. In most places it is in areas more than 100 acres in size.

Included with this soil in mapping are narrow bands of Rock outcrop and rock escarpments. Rock outcrop is throughout the area, and in most places the escarpments are on ridgetops. Also included near the base of slopes are small areas of Colluvial land. Included Rock outcrop, rock escarpment, and Colluvial land make up about 20 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is high.

All of the acreage of this soil is in native range. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Terrace Escarpments

Terrace escarpments (Te) are on side slopes of old outwash fans and terraces in the central part of the Area (fig. 4). Soil areas are long and narrow.

These areas consist of undifferentiated shallow soils that have many cobbles and stones on the surface. In many places there is merely a thin layer of cobbles over sandstone or shale.

Included in mapping are some deeper soils near the bottom of slopes.

Runoff is rapid, and the erosion hazard is high. Terrace escarpments take in water slowly, but in places intake of water is influenced by the amount of stones and cobblestones on the surface. Only limited moisture is available for plants because these undifferentiated soils are shallow.

Terrace escarpments is not suited to cultivation. It is used for native range. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Valmont Series

The Valmont series is made up of deep, well-drained soils. These soils formed on old high terraces and benches in gravelly and cobbly loamy alluvium. Slopes are 1 to 25 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly tall and mid grasses. Annual precipitation is 12 to 18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer, about 4 inches thick, is a grayish-brown light clay loam that contains varying amounts of cobbles and gravel. The upper part of the subsoil is brown clay loam about 3 inches thick. The middle part is brown light clay about 13 inches thick. The lower part is calcareous, light-brown gravelly clay loam about 4 inches thick. The underlying material is calcareous, pinkish-white and light-brown very gravelly loam. In the surface layer, soil reaction is neutral, but with increasing depth it becomes moderately alkaline.

Valmont soils have moderately slow permeability. Available water capacity for the profile is moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops and for pasture.

Representative profile of Valmont clay loam, 3 to 5 percent slopes, located 800 feet east of the northwest corner of sec. 7, T. 3 N., R. 69 W.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, very friable; 5 percent gravel; neutral; clear, smooth boundary.

Figure 4.—Outwash fans and terraces with Terrace escarpments in the foreground and in the sloping areas.

B1t—4 to 7 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard, friable; few thin clay films on vertical faces of some aggregates; 10 percent gravel; neutral; clear, smooth boundary.

B2t—7 to 20 inches, brown (10YR 5/3) light clay, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, angular blocky; extremely hard, firm; thin continuous clay films on faces of aggregates; 10 percent gravel; mildly alkaline; clear, wavy boundary.

B3ca—20 to 24 inches, light-brown (7.5YR 6/3) gravelly clay loam, brown (7.5YR 5/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; very hard, firm; common, thin clay films on faces of aggregates; 15 percent gravel; calcareous, with few to common, fine to medium, white (10YR 8/2) lime seams and streaks; moderately alkaline; gradual, wavy boundary.

IIC1a—24 to 35 inches, pinkish-white (7.5YR 8/2) very gravelly loam, pink (7.5YR 8/4) when moist; massive; very hard, very friable; 50 percent gravel and cobblestones; calcareous with many fine and few medium, white (10YR 8/2), soft segregations of lime; moderately alkaline; gradual, wavy boundary.

IIC2ca—35 to 60 inches, light-brown (7.5YR 6/3) very gravelly loam, brown (7.5YR 5/3) moist; massive; hard, very friable; 50 to 75 percent gravel and cobblestones calcareous with many, fine and medium, white (10YR 8/2) soft segregations and hard coatings of lime on under sides of rock fragments; moderately alkaline.

The A1 horizon ranges from 4 to 12 inches in thickness and from loam to clay loam in texture. Texture of the B2t horizon ranges from a heavy clay loam to clay that may be gravelly or cobbly. Depth to calcareous material ranges from 8 to 20 inches. Depth to underlying cobblestones and gravel ranges from 20 to 40 inches. Content of cobblestones and gravel in the A and B horizons normally ranges from 5 to 30 percent, but it may be as high as 50 percent in the surface layer of cobbly phases. In the C horizon, the content of cobblestones and gravel ranges from 50 to 70 percent.

Valmont clay loam, 1 to 3 percent slopes (VaB).—This soil is on terraces and fans mainly in the central part of the Area. In most places it occurs as areas more than 40 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 9 inches of clay loam. The subsoil is about 6 inches of clay that grades into limy clay loam about 14 inches thick.

Included with this soil in mapping are a few areas that have a seasonal high water table. Also included are small areas of Valmont cobbly clay loam, 1 to 5 percent slopes; and Nunn clay loam, 1 to 3 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate. Fertlity is medium.

Most of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units

IIIe–3, irrigated, and IIIs–1, nonirrigated; tree suitability group 3)

Valmont clay loam, 3 to 5 percent slopes (VaC).—This soil is on terraces and fans, mainly in the west-central part of the Area. In most places it is in long, narrow areas more than 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Valmont clay loam, 1 to 3 percent slopes; Nunn clay loam, 3 to 5 percent slopes; and Valmont cobbly clay loam, 1 to 5 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this soil. The erosion hazard is moderate.

All of the acreage of this soil is used for irrigated and dryland crops and for pasture. (Capability units IIIe–2, irrigated, and IIIe–7, nonirrigated; tree suitability group 3)

Valmont cobbly clay loam, 1 to 5 percent slopes (VcC).—This soil is on high terraces and outwash fans in the west-central part of the Area. In most places it is in areas more than 20 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 8 inches of cobbly clay loam. The subsoil is about 14 inches of cobbly clay loam or cobbly clay (fig. 5).

Included with this soil in mapping is a Valmont-like soil that is redder than this soil, that has less than 10 percent gravel and cobblestones, and that contains some depressions supporting no vegetation and having a crusted surface layer. Also included are small areas of Valmont clay loam, 3 to 5 percent slopes. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is slight to moderate.

This soil is not well suited to cultivation and the harvesting of crops because it has too many cobblestones and too much gravel on its surface. It is, however, a good grass-producing soil. Most of the acreage is used for native range. A few small areas are used for irrigated pasture. (Capability units Vs–1, irrigated, and VIIs–1, nonirrigated; tree suitability group 6)

Valmont cobbly clay loam, 5 to 25 percent slopes (VcE).—This soil is on the side slopes of high terraces or outwash fans, mainly in the south-central part of the Area. In most places it is in long, narrow areas more than 20 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 6 inches of cobbly clay loam. The subsoil is about 12 inches of cobbly clay or clay loam. There are varying amounts of gravel and cobblestones throughout the profile.

Included with this soil in mapping are a few small areas of a Valmont-like soil that has a layer of gravel at a depth of more than 40 inches. A few minor areas have shale or sandstone underlying the very gravelly layers within a depth of 40 inches from the surface. Also included are some small areas of Valmont cobbly clay loam, 1 to 5 percent slopes. Included soils make up about 20 percent of each mapped area.

Runoff is medium to rapid on this soil. The erosion hazard is moderate to high.

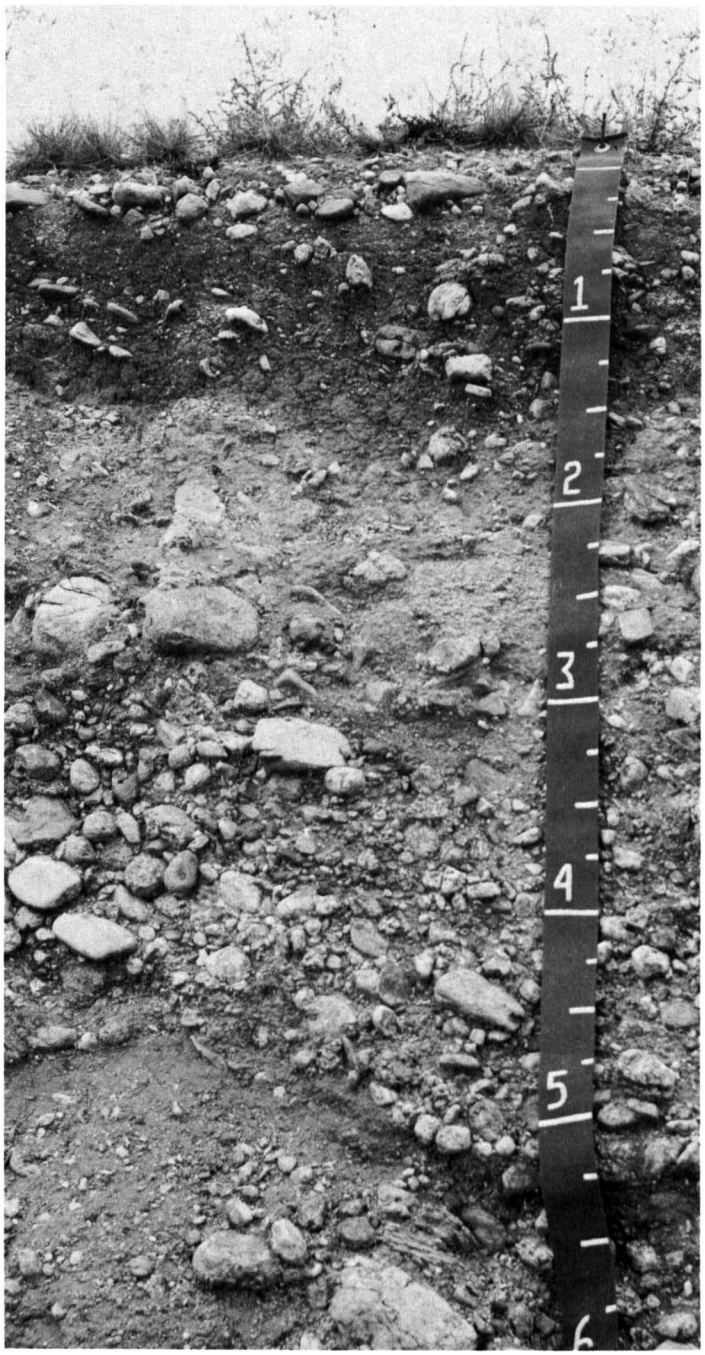

Figure 5.—**Profile of Valmont cobbly clay loam, 1 to 5 percent slopes.**

All of the acreage of this soil is used for native range. (Capability unit VIIs–1, nonirrigated; tree suitability group 6)

Weld Series

The Weld series is made up of deep, well-drained soils. These soils formed on smooth uplands, mainly in loamy wind-laid parent material. Slopes are 0 to 5 percent. Elevations are 4,900 to 5,500 feet. The native vegetation is mainly short grasses. Annual precipitation is 12 to

18 inches. Mean annual air temperature is 48° to 52° F., and the frost-free season is about 140 to 155 days.

In a representative profile the surface layer is brown loam about 6 inches thick. The subsoil, about 6 inches thick, is a brown clay that grades to a strongly calcareous, pale-brown clay loam. The substratum is strongly calcareous, pale-brown loam that extends to a depth of 60 inches or more. In the surface layer, soil reaction is neutral, but with increasing depth it becomes alkaline.

Weld soils have slow permeability. Available water capacity for the profile is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for irrigated and dryland crops.

Representative profile of Weld loam, 1 to 3 percent slopes, located 2,590 feet east of the northwest corner of sec. 7, T. 1 N., R. 69 W.:

Ap—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

B2t—6 to 12 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; strong, medium, prismatic structure that parts to strong, medium, angular and subangular blocky; hard, firm; thin, continuous clay films on ped faces; neutral; clear, smooth boundary.

B3tca—12 to 18 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; moderate, coarse, prismatic structure that parts to moderate, medium, subangular blocky; patchy clay films on faces of aggregates; strongly calcareous; mildly alkaline; clear, smooth boundary.

C1ca—18 to 24 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable; strongly calcareous, with many, fine and medium, white (10YR 8/2) lime mycelia; moderately alkaline; gradual, smooth boundary.

C2ca—24 to 60 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive; slightly hard, friable; strongly calcareous; moderately alkaline.

The A1 horizon ranges from 6 to 14 inches in thickness and from loamy sand to loam in texture. The B2t horizon ranges from heavy clay loam to clay in texture. Structure ranges from moderate to strong prismatic that parts to moderate or strong angular and subangular blocky. Depth to calcareous material ranges from 11 to 30 inches. The C horizon ranges from loam to silt loam or light clay loam in texture.

Weld loamy sand, 1 to 4 percent slopes (WdB).—This soil is in the areas near Lafayette. In most places it is in irregular areas more than 30 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is in two parts. The upper part is about 6 inches of loamy sand, and the lower part is about 6 inches of light sandy loam. The subsoil is about 19 inches of a heavy clay loam that grades to limy clay loam at a depth of about 5 inches.

Included with this soil in mapping are small areas of Ascalon sandy loam, 1 to 3 percent slopes; and Weld fine sandy loam, 1 to 3 percent slopes. These included soils make up about 10 percent of each mapped area.

Runoff is slow. The erosion hazard is high. Soil blowing is the greatest hazard. This soil is easily worked.

All of the acreage of this soil is cultivated. About half of the acreage is used for irrigated crops. (Capability units IIIe–5, irrigated, and IVe–9, nonirrigated; tree suitability group 4)

Weld fine sandy loam, 1 to 3 percent slopes (WeB).—This soil is on the uplands in the east-central part of the Area. In most places it occurs as irregularly shaped areas more than 15 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 8 inches of fine sandy loam. The subsoil is about 5 inches of heavy clay loam underlain by about 15 inches of limy clay loam.

Included with this soil in mapping are small areas of Weld soils that have slopes steeper than 3 percent. Also included are small areas of Colby loam, a few small areas of Ascalon sandy loam, 1 to 3 percent slopes, and a few areas of Weld loam, 1 to 3 percent slopes. These inclusions make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate. Soil blowing is the greatest hazard.

Almost all of the acreage of this soil is used for dryland crops. A few areas are used for irrigated crops. (Capability units IIe–2, irrigated, and IIIe–8, nonirrigated; tree suitability group 3)

Weld loam, 0 to 1 percent slopes (WlA).—This soil is on the uplands in the eastern part of the Area. In most places it occurs as irregularly shaped areas more than 20 acres in size.

The profile of this soil is much like the one described as representative for the series, but the surface layer is about 10 inches of loam. The subsoil is about 6 inches of clay underlain by about 10 inches of clay loam that is limy in the lower part.

Included with this soil in mapping are small areas of Colby loam and a few small areas of Weld loam, 1 to 3 percent slopes. Also included, where fields have been leveled, are a few areas of Weld soils that have a thicker and lighter colored surface layer. These included soils make up about 10 percent of each mapped area.

Runoff is slow on this soil. The erosion hazard is slight.

Almost all of the acreage of this soil is used for irrigated crops. A few small areas are used for dryland crops. (Capability units IIs–1, irrigated, and IIIc–1, nonirrigated; tree suitability group 3)

Weld loam, 1 to 3 percent slopes (WlB).—This soil is on the uplands in the eastern part of the Area. In most places it occurs as irregularly shaped areas more than 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Weld loam, 0 to 1 percent slopes, and where fields have been leveled, small areas of Colby loam. Also included are a few small areas that have a seasonal high water table within the root zone. The included soils make up about 15 percent of each mapped area.

Runoff is medium on this soil. The erosion hazard is moderate.

Most of the acreage of this soil is used for irrigated crops. The rest is used for dryland crops. (Capability units IIe–1, irrigated, and IIIc–1, nonirrigated; tree suitability group 3)

Weld-Colby complex, 0 to 3 percent slopes (WoB).—This complex is on the uplands, mainly in the northeastern part of the Area. It consists of about 55 percent Weld soils and about 30 percent Colby silty clay loam. Most areas are larger than 20 acres in size and are irregular in shape. Weld soils are on the smoother parts of the

landscape. Colby soils are in the more sloping areas that have been leveled or eroded.

Weld soils have a profile much like the one described as representative for the series, but in some places the surface layer is fine sandy loam.

Colby silty clay loam has a profile much like the one described as representative for the Colby series.

Included with this complex in mapping are some areas that have a Weld-like soil, but the surface layer is thicker or thinner or is lighter colored as a result of leveling. Also included are a few small areas that have a seasonal high water table. These included soils make up about 15 percent of each mapped area.

Runoff is medium on this complex. The erosion hazard is moderate.

All of the acreage of this complex is used for irrigated and dryland crops. (Capability units IIe–1, irrigated, and IIIc–1, nonirrigated; tree suitability group 3)

Weld-Colby complex, 3 to 5 percent slopes (WoC).—This complex is on the uplands in the northeastern part of the Area. It consists of about 50 percent Weld fine sandy loam and 35 percent Colby silty clay loam. Most areas are larger than 20 acres in size and are irregular in shape. Weld soils are on the smoother parts of the landscape. Colby soils are in areas that are less smooth and in areas that have been leveled or eroded.

Weld soils have a profile much like the one described as representative for the series, but in some places the surface layer is fine sandy loam.

Colby silty clay loam has a profile much like the one described as representative for the Colby series.

Included with this complex in mapping are small areas of Weld-Colby complex, 0 to 3 percent slopes, and a few areas having a surface layer that is lighter colored than is typical of Weld soils. These included soils make up about 15 percent of each mapped area.

Runoff is rapid on this complex. The erosion hazard is moderate to high.

All of the acreage of this complex is used for irrigated and dryland crops. (Capability units IIIe–2, irrigated, and IIIe–7, nonirrigated; tree suitability group 3)

Use and Management of Soils

This section discusses cropping systems and general management of irrigated and nonirrigated soils. The system of capability classification used by the Soil Conservation Service is explained, and management by capability groups is discussed. Tables give predicted yields of the principal irrigated and nonirrigated crops. Suggestions for the use and management of soils for native grassland, woodland and tree planting, recreation, and wildlife are included in this section. Also discussed are engineering and urban uses of the soils.

Management of Irrigated Soils

The first part of this section gives general information about irrigation methods and crops and cropping practices in the Boulder Area; the second part discusses the irrigated capability units in the Area; and the third gives predicted average acre yields for the principal irrigated crops under a high level of management.

In 1968 about 68,000 acres in the Boulder Area was irrigated. The irrigated areas are mainly in the eastern part of the survey area, although a few areas of meadowland are irrigated in the foothill and mountainous part. Most of the irrigation and domestic water for the Area is taken from two main sources, the (1) various streams and (2) their storage reservoirs. The main streams are Boulder Creek and South Boulder Creek, Left-hand Creek, and St. Vrain Creek.

Most of the water from the creeks is stored in reservoirs during spring runoff and released for irrigation as needed. Highlands Reservoir No. 2 has a storage capacity of 3,765 acre-feet; Foothills Reservoir, 4,345 acre-feet; Base Line Lake, 5,300 acre-feet; Marshall Lake, 10,258 acre-feet; and Left-hand Valley Reservoir, 3,800 acre-feet. There are also numerous smaller lakes and reservoirs.

In addition to these sources of water, much of the Area is served by the Colorado Big Thompson Transmountain Diversion Project, which supplies supplemental water, and in most years, insures a supply of late-season irrigation water.

A few areas obtain water from wells, but the number of wells in the Boulder Area is limited. Additional information about the wells and about the chemical analysis of the water can be obtained from the U.S. Geological Survey.[1]

Irrigation methods

The five principal methods of irrigating the soils in the Area are by furrows, borders, controlled flooding, sprinklers, and corrugations.

Furrow irrigation (fig. 6) is used where row crops are grown. When this method is used, the water is

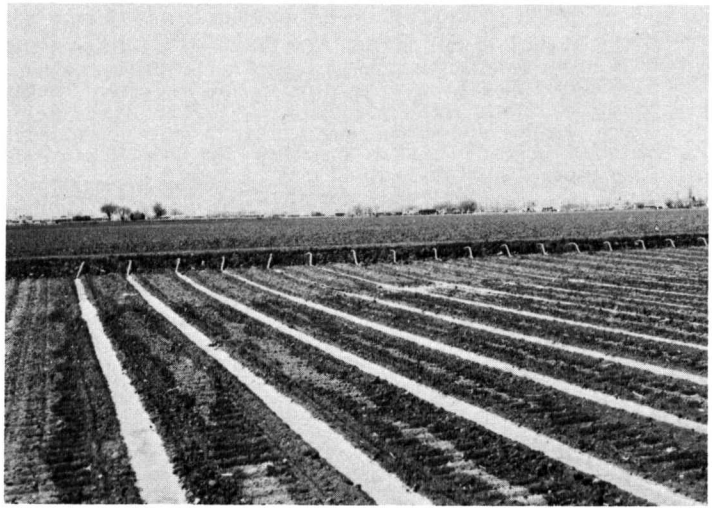

Figure 6.—**Pre-emergence furrow irrigation of sugar beets using siphon tubes on McClave clay loam.**

taken from ditches by siphon tubes, by gated pipe, or by cuts in the ditchbank, and is applied in the furrows between the rows of plants. On sloping soils, the use of

[1] JENKINS, E. D. RECORDS AND LOGS OF SELECTED WELLS AND TEST HOLES, AND CHEMICAL AND RADIOMETRIC ANALYSIS OF GROUND WATER IN THE BOULDER AREA, COLORADO. Colorado Water Conservation Board Basic—Data Report No. 5, 30 pp. 1961.

contour furrows helps to control erosion by carrying water across the slope. On nearly level soils, the furrows are straight.

Border irrigation is used on nearly level fields that are planted to close-growing crops. When this method is used, the water flows down a narrow strip between the ridges, and the water soaks into the soil as it advances. Uniform grades are necessary, however, to insure an even distribution of water and to prevent ponding.

Controlled flooding is used on close-growing crops. Water is flooded down the slope between closely spaced field ditches.

Sprinkler irrigation is used in the Area mainly where slopes are steep or uneven. Sprinklers are an advantage in establishing pasture crops and in pre-emergence irrigation of certain crops. With this method of irrigating, however, water losses resulting from evaporation may be higher than with other methods of irrigation, and wind drift may cause uneven application of water.

Corrugation irrigation is useful on fields that do not have uniform grades. Corrugations are used mainly on fields growing close-drilled or broadcast crops.

Irrigation practices

If plants are to receive the amount of moisture they need, water must be applied efficiently. Irrigation is inefficient when water is allowed to penetrate below the root zone. This water is lost when runoff occurs at the end of the field, or when it escapes through seepage and in ditches. Water seeps down below the root zone if the irrigation runs are too long or if the water is allowed to run too long on the same set. Also if the runs are too long or if the amount of water used is too small for the length of the run, the soils at the upper end of the run likely will be wet below the root zone before the soils at the lower end have received enough water. This is especially likely in sandy soils or in soils that have a root zone that is shallow over sand. Wetting the soil below the root zone has little value and is likely to create drainage problems.

A good irrigation system is one that enables the farmer to apply the needed amount of moisture to the soil with little waste. The amount of moisture that can be retained by the soil depends largely on the texture and thickness of the soil. Generally, loamy sands and fine sand hold about 0.05 to 0.08 inches of water per inch of soil depth; sandy loams, about 0.11 to 0.13 inches per inch; loam or silt loam, about 0.16 to 0.18 inches per inch; clay loam about 0.19 to 0.21 inches per inch; and clays, about 0.14 to 0.17 inches per inch. In order to obtain a maximum rate of growth, an irrigation system that uses not more than one-half of the available moisture capacity at the root zone is necessary.

Irrigating in such a manner as to obtain high production without waste of either water or soil requires the knowledge of certain fundamental management practices. These practices can mean saving in water, control of erosion, higher crop yields, lower labor costs, and continued production. In the Boulder Area, the following practices are used.

Land leveling.—The farmer who irrigates his soils needs to be able to apply water uniformly and to conserve water and labor. Land leveling helps to do these things, and it is necessary if border irrigation is used. Most land leveling is done in areas that are already nearly level, for in such areas less soil material must be moved for good results. Where land leveling is to be done, the kinds of soils, the relief, and the general topography must all be considered.

Drainage.—Many of the soils of the Area need to be drained if they are to be cropped to their fullest potential. Both tile drains and open drains are used. Once drained, many of the soils need to be leached of excessive accumulations of salts. In most cases, this can be done by applying excessive amounts of irrigation water, but on some soils, chemical amendments may be helpful. Growing salt-tolerant crops, such as barley or sugar beets, may be necessary until leaching is accomplished.

Erosion control.—Control of erosion is always important on irrigated soils. Planting the steeper slopes to close-growing crops; irrigating on the contour or across the slope; and careful applications of irrigation water are methods that prevent excessive erosion. Installations of pipeline or concrete-lined ditches (fig. 7) are also helpful in preventing excessive ditch erosion, and thus in conserving water.

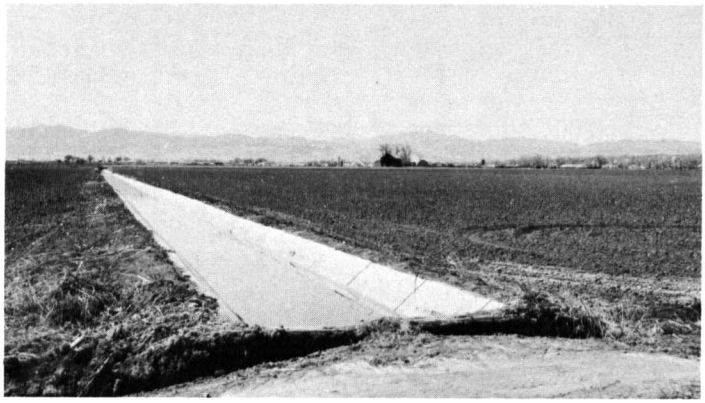

***Figure 7.*—Concrete-lined irrigation ditch on McClave clay loam.**

Crops and cropping practices

The main irrigated crops in the Area are alfalfa, corn, sugar beets, small grain, dry beans, and pasture grasses. The length of the frost-free season, 140 to 155 days, permits three cuttings of alfalfa and allows for the maturation of selected varieties of corn. In recent years the acreage of dry beans has increased, and the acreage of sugar beets has decreased. These acreages vary somewhat, according to demand of the crop and to the labor supply. Vegetable crops, such as sweet corn, tomatoes, cucumbers, cabbage, onions, peppers, peas, pumpkins, and red beets, are also well adapted to the Area and are grown on limited acreages.

A good cropping system includes a sequence of crops that helps maintain soil tilth and fertility and helps control insects, diseases, and weeds. A suitable sequence includes alfalfa or another soil-building crop. A system of fertilizing is also necessary for producing continued high yields. Fertilizer should be applied according to soil tests. In areas that have been leveled with deep cuts, applications of manure are particularly helpful in restoring tilth and fertility.

Capability groups of soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.[2]

In the capability system, all the soils are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses identified by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding Arabic numerals to the subclass symbol, for example, IIw–2 or IIIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit.

In the following pages the capability units in the Boulder Area are described and suggestions for the use and management of the soils are given. Soils used for irrigation farming are classified into irrigated capability units and are shown first. They are followed by the nonirrigated capability units. The capability unit for all the soils in the survey area is shown in the "Guide to Mapping Units," at the back of this survey.

CAPABILITY UNIT I (IRRIGATED)

This unit consists of deep, well-drained soils of the Ascalon and Nunn series. These soils have a sandy loam and sandy clay loam surface layer and a sandy clay loam and clay subsoil. Slopes are 0 to 1 percent. Permeability is moderate to moderately slow. Runoff is slow, and the erosion hazard is slight. Available water capacity is high. The effective rooting depth is 60 inches or more.

The soils in this capability unit are suited to all of the irrigated crops of the Area. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn, sugar beets, and small grain. Vegetables can be substituted for either corn or sugar beets in the rotation. Leaving stubble or other crop residue on the surface helps to maintain tilth and to protect these soils from possible damage caused by soil blowing during windy periods in spring. If the soils are left bare for long periods during spring, a cloddy or ridged surface helps minimize wind damage.

Nearly all of the irrigation methods commonly used are suitable. Border, corrugation, or sprinkler irrigation is suited to alfalfa and small grain. Corrugations and controlled flooding are suited to pasture and to fields that must be irrigated with a short supply of water. Furrow or sprinkler irrigation is well adapted for row crops. The irrigations runs can be relatively long.

Corn, sugar beets, and small grain respond well to applications of nitrogen fertilizer, and sugar beets and alfalfa respond to phosphorus fertilizers.

These soils are suitable for irrigated pasture.

CAPABILITY UNIT IIe–1 (IRRIGATED)

This capability unit consists of deep, well-drained soils of the Colby, Kim, Manvel, Nunn, and Weld series. These soils have a loam, silty clay loam, or clay loam surface

[2] SOIL CONSERVATION SERVICE, U.S. DEPARTMENT OF AGRICULTURE. LAND-CAPABILITY CLASSIFICATION. Agriculture Handboook No. 210. 21 pp. 1961.

layer. The subsoil or underlying layer is loam, sandy clay loam, silty clay loam, clay loam, or clay. Slopes are 1 to 3 percent. Permeability is moderate to slow. Runoff is medium, and the erosion hazard is moderate. Available water capacity is high. The effective rooting depth is 40 to 60 inches or more. A few small areas have a seasonal high water table at a depth of 3 to 5 feet.

The soils in this capability unit are suited to all of the irrigated crops of the Area. A systematic crop rotation should be followed in order to maintain soil tilth. A suitable cropping system is alfalfa 3 or 4 years, followed by corn, sugar beets, and small grain. Vegetable crops can be substituted for corn or sugar beets in the rotation. To minimize erosion losses and to maintain soil tilth, row crops should be limited to no more than 3 consecutive years. Use of high residue crops, such as a small grain and occasionally a green-manure crop helps to increase intake of water and to improve tilth, so that these soils can be worked more easily. The clay loam soils of this unit are easier to work in spring if they are plowed in the fall.

Nearly all of the methods of irrigating commonly used are suitable. Border ditches will erode on these slopes, however, and are not recommended. Sprinklers can be used on all of the crops grown. Borders, corrugations, and controlled flooding between contour ditches can be used for irrigating alfalfa and small grain. Row crops can be irrigated by furrows and contour furrows. Irrigating with a small head of water and shortening the length of irrigation runs help to control erosion on the more sloping soils. In order to reduce excessive ditch cutting, all supply ditches should have a drop structure, if they run down the slope.

Crops grown on soils of this unit respond well to applications of fertilizer containing nitrogen and phosphorus.

These soils are suited to irrigated pasture.

CAPABILITY UNIT IIe–2 (IRRIGATED)

This unit consists of deep, well-drained soils of the Ascalon, Nunn, Otero, and Weld series. These soils have a fine sandy loam, sandy loam, or sandy clay loam surface layer and a subsoil or underlying layer of sandy loam, sandy clay loam, clay loam, or clay. Slopes are 0 to 3 percent. Permeability is slow to moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

The soils in this capability unit are suited to all of the irrigated crops of the Area, but they must have an adequate supply of water. The soils should be leveled to a uniform grade to facilitate proper management or irrigation water. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn or sugar beets, and then small grain for 2 years. Vegetable crops can be substituted for corn or sugar beets in the rotation. Areas exposed to strong winds can be protected by leaving stubble on the ground or by leaving the surface rough or ridged.

Nearly all of the irrigation methods commonly used are suitable. Border ditches are not suitable for some crops because the ditches erode on these slopes. Sprinklers can be used on all of the crops grown. Borders, corrugations, and controlled flooding between contour ditches can be used for irrigating alfalfa and small grain. Corn and sugar beets can be irrigated by furrows and contour furrows. Irrigation heads should be small and the runs relatively short, so that erosion is controlled and the penetration of water is improved.

Crops grown on soils of this unit respond well to applications of fertilizer containing nitrogen and phosphorus.

These soils are suited to irrigated pasture.

CAPABILITY UNIT IIs–1 (IRRIGATED)

This unit consists of deep, well-drained soils of the Nunn and Weld series. These soils have a clay loam and loam surface layer and a clay subsoil. Slopes are 0 to 1 percent. Permeability is slow. Runoff is slow, and the erosion hazard is slight. Available water capacity is high. The effective rooting depth is 60 inches or more.

The soils in this capability unit are suited to all of the irrigated crops of the Area. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn, sugar beets, small grain, and then alfalfa seeded with a small grain as a nurse crop. Vegetable crops can be substituted for corn or sugar beets in the rotation.

These soils are easier to work down for seedbed preparation if they are plowed in the fall. Occasional subsoiling when the ground is dry will temporarily open the soil to air, water, and plant roots. If intensive row cropping is planned, barnyard manure or a green-manure crop should be plowed under in order to maintain the rate of water intake and improve soil tilth.

Suitable methods of irrigation are borders, corrugations, contour ditches, furrows, and sprinklers. The irrigation runs can be long because of the slow permeability. Where irrigation runs can be short, small heads of water can be used to wet the root zone and lengthen time between irrigations.

Crops grown on these soils respond to fertilizer containing nitrogen and phosphorus. Use of crop residue helps improve tilth, so that these soils can be worked more easily.

These soils are suited to irrigated pasture.

CAPABILITY UNIT IIw–1 (IRRIGATED)

This unit consists of deep, somewhat poorly drained soils of the Colby and McClave series. These soils have a clay loam and silty clay loam surface layer and a clay loam and silty clay loam underlying layer. Slopes are 0 to 3 percent. Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. Available water capacity is high. The effective rooting depth is 60 inches or more. A seasonal fluctuating water table is at a depth between 2 and 4 feet.

The soils in this capability unit are suited to most of the irrigated crops of the Area. Salt-tolerant crops, such as barley and sugar beets, are especially suitable, and salt-sensitive crops, such as potatoes and onions, are unsuitable. To maintain maximum crop production, the soils should be drained. Even if they are not drained, they can be used for crops, but the water table should be maintained at a nearly constant level. Unless the water table is controlled, yields and life of perennial crops, such as alfalfa, will be less.

Irrigating with relatively short runs is necessary to prevent overirrigation. Frequent, light irrigations minimize accumulation of salts.

Crops grown on soils of this unit respond well to fertilizer containing nitrogen and phosphorus.

These soils are well suited to irrigated pasture. Salt-tolerant and water-tolerant grasses should be planted. Tall wheatgrass and tall fescue are both good pasture grasses. Yellowblossom sweetclover adds to the value of the forage. Nitrogen fertilizer increases vigor of the grasses. Good management of pasture is necessary.

CAPABILITY UNIT IIw-2 (IRRIGATED)

This unit consists of deep, somewhat poorly drained soils of the Calkins series. These soils have a surface layer and underlying layer of sandy loam. Slopes are 0 to 3 percent. Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight to moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. A seasonal high water table is between a depth of 2 and 4 feet.

The soils of this capability unit are suited to most of the irrigated crops of the Area. Water-tolerant crops are especially well suited.

To maintain maximum crop production, the soils need to be drained. Where they are not drained, they can be used for crops if the water table is kept at a nearly constant level. Unless the water table is controlled, yields and life of alfalfa and similar perennial crops are less. Since these soils have a moderate available water capacity, the water table can be beneficial. Crop residue left on the surface during the windy spring months helps to control soil blowing and to increase the organic-matter content of the soil.

Irrigating with relatively short runs helps prevent overirrigation and the resulting extreme fluctuation in the water table. Frequent, light irrigations are necessary.

These soils are suited to irrigated pasture. Water-tolerant grasses, such as tall wheatgrass, tall fescue, or slender wheatgrass, are good in pastures. The addition of Alsike clover or alfalfa increases value of the forage. Nitrogen fertilizer increases vigor of the grasses. Good management of pasture is necessary.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

The one soil in this unit, Heldt clay, 0 to 3 percent slopes, is deep and moderately well drained. It has a surface layer and subsoil of clay. Slopes are 0 to 3 percent. Permeability is slow. Runoff is medium to rapid, and the erosion hazard is moderate. Available water capacity is high. The effective rooting depth is 60 inches or more.

This soil is used for irrigated crops. Its low rate of water intake and the hazard of erosion make intensive row cropping hazardous. Row crops should be limited to no more than 2 years in the crop rotation. If alfalfa and small grain are included in the rotation, they provide protection from erosion and help maintain soil tilth. Where row crops are grown, the soil should be leveled and the rows slanted across the slope. Irrigating row crops is now difficult because the head of water must be kept small, and therefore, it takes a long time to wet the ground. Keeping the number of tillage operations to a minimum helps to prevent loss of organic matter content and to maintain a protective soil cover.

Generally, border and sprinkler methods of irrigation are not suitable. Contour ditches and corrugations can be used for irrigating crops drilled in closely spaced rows and for pasture. Row crops can be irrigated by furrows and contour furrows. In order to reduce excessive ditch cutting, all supply ditches that run down the slope should have a drop structure.

Crops grown on this soil respond to fertilizer containing nitrogen and phosphorus. Use of plant residue helps improve the tilth so that the soil can be worked more easily. Feedlot manure is especially good because it provides organic matter and plant nutrients.

This soil is suited to pasture. Pastures can be grazed or cut over for hay. Smooth bromegrass and orchardgrass are suitable pasture grasses. The addition of Alsike clover or alfalfa increases the value of the forage.

CAPABILITY UNIT IIIe-2 (IRRIGATED)

This unit consists of deep, well-drained soils of the Colby, Nunn, Valmont, and Weld series. These soils have a silty clay loam or clay loam surface layer and a silty clay loam, clay loam, or clay subsoil or underlying layer. Slopes are 3 to 5 percent. Permeability is moderate to slow. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is high. The effective rooting depth is 60 inches or more.

Included in this unit is Weld fine sandy loam that is mapped as part of the Weld-Colby complex, 3 to 5 percent slopes. Use and management practices are similar to those for the other soils in the unit.

The soils of this capability unit are suited to most of the irrigated crops of the Area. They are too steep for continuous vegetable cropping, however. If alfalfa and small grain are included in the rotation, they provide protection from erosion and help maintain soil tilth. Row crops should be limited to no more than 2 years in the rotation.

Border irrigation is not suitable. Sprinklers are suited to all of the crops grown. The soils should be smoothed to remove excessive side slopes. Closely spaced contour ditches allow controlled flooding of such drill crops as small grain or alfalfa. Row crops can be irrigated by contour furrows. The irrigation runs should be relatively short so that erosion is minimized.

Crops grown on soils of this unit respond well to fertilizer containing nitrogen and phosphorus.

These soils are well suited to pasture, and if they are well managed, the hazard of erosion can be minimized. Smooth bromegrass and orchardgrass are suitable pasture grasses. The addition of alfalfa or Alsike clover increases the value of the forage.

CAPABILITY UNIT IIIe-3 (IRRIGATED)

The one soil of this capability unit, Valmont clay loam, 1 to 3 percent slopes, is deep and well drained. It has a clay loam surface layer and a clay loam and clay subsoil. The underlying material is very gravelly or cobbly loam. Permeability is moderately slow. Runoff is medium, and the erosion hazard is moderate. Available water capacity is moderate. The effective rooting depth is 60 inches or more.

This soil is suited to most of the irrigated crops of the Area. Corn, alfalfa, and small grain are the main crops. If alfalfa is in the crop rotation for 3 or 4 years and small grain for 1 year, protection from erosion is provided and soil tilth is maintained. Row crops should be limited to no more than 2 years in the rotation. If row crops are grown, the soil should be leveled and the furrows angled across the slope.

Borders, corrugations, and contour ditches, as well as sprinklers, can be used for irrigating close-growing crops. Row and vegetable crops can be irrigated by furrow, contour furrow, and sprinklers. Irrigation heads should be small and the length of irrigation runs short, so that penetration of water is improved. Because of the limited available water capacity, frequent irrigations are necessary. Leveling to remove surface irregularities and to facilitate control of irrigation water must be restricted to cuts less than 1½ feet deep. The underlying very gravelly soil material may be exposed if cuts exceed this depth, and this may result in a substantial reduction in the available water capacity.

Crops grown on the soil of this unit respond well to application of fertilizer containing nitrogen and phosphorus. Soil tilth and fertility can be maintained by applying manure at least once during each crop rotation.

These soils are well suited to permanent grass for pasture or hay. Smooth bromegrass and orchardgrass are suitable pasture grasses. The addition of Alsike clover or alfalfa will increase the value of the forage. In order to maintain production, pastures should be rotated and grazing should be limited so that a minimum of 3 inches of stubble is left on the soil (fig. 8).

CAPABILITY UNIT IIIe-4 (IRRIGATED)

This capability unit consists of deep, well drained soils of the Manter series. These soils have a surface layer and subsoil of sandy loam and an underlying layer of loamy sand. Slopes range from 0 to 3 percent. Permeability is moderately rapid. Runoff is slow to medium. The hazard of water erosion is moderate to slight, and the hazard of soil blowing is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more. Some areas have a seasonal high water table within a depth of 3 feet.

These soils are suited to most of the crops commonly grown in the Area; however, the amount of irrigation water available late in the cropping season may not be adequate for vegetable crops, such as potatoes, beets, and onions. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn and small grain. Vegetable crops can be substituted for corn in the rotation. Unless the soil is leveled and rows slanted across the slope, row crops should be limited to no more than 2 years in the cropping rotation.

Border, contour ditches, and sprinklers can be used for irrigating close-growing crops. Row crops can be irrigated by furrows, contour furrows, and sprinklers. Be-

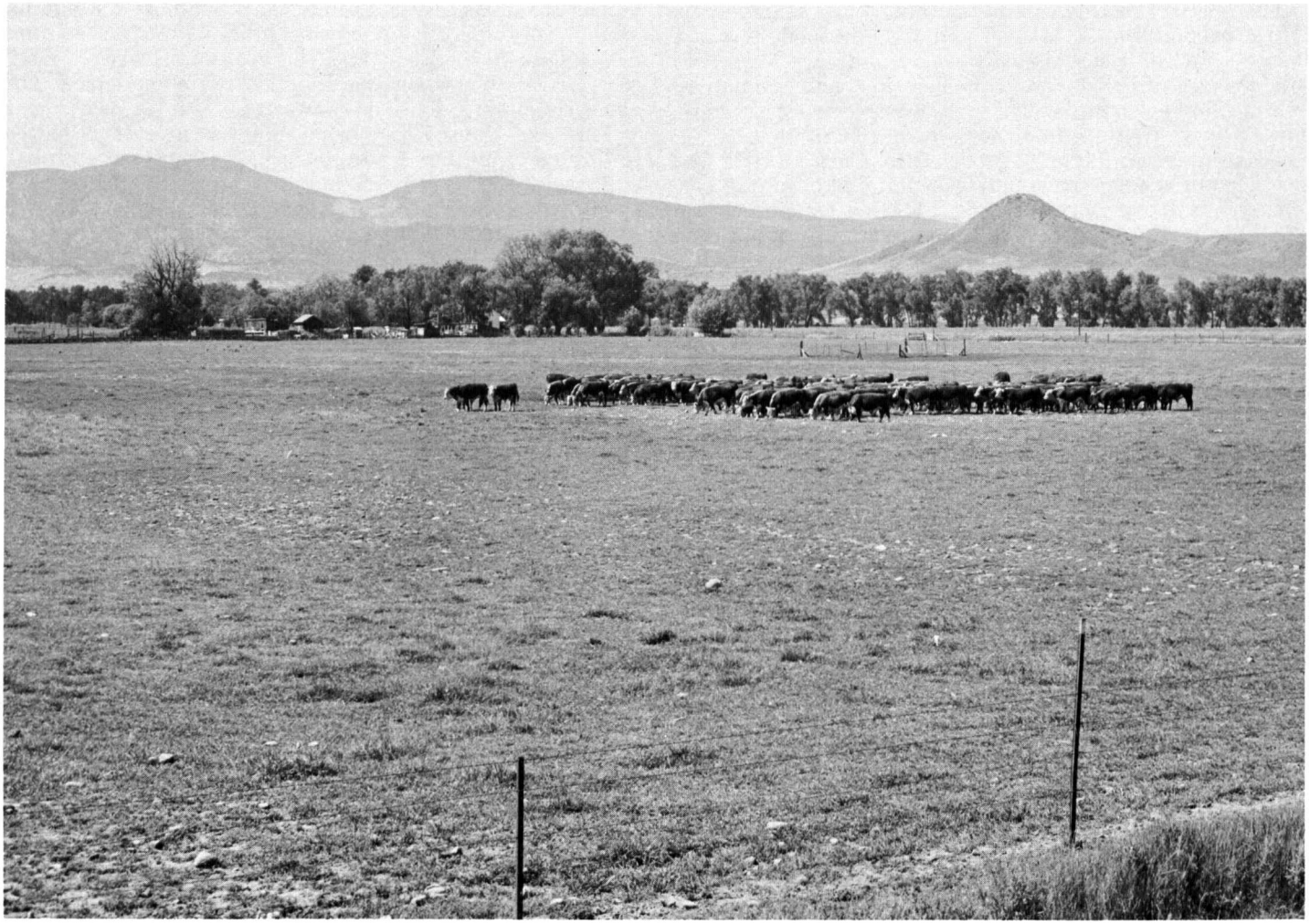

Figure 8.—Feeder steers grazing on irrigated pastures on Valmont clay loam, 1 to 3 percent slopes.

cause erosion is a hazard, irrigation runs should be short and irrigation heads small. Some shallow-rooted crops need irrigation as often as once a week.

Windbreaks should be established to help control soil blowing. Fields should not be bare during December through February, and crop residue should be left on the surface in order to minimize soil losses caused by soil blowing.

Grain crops grown on these soils respond to applications of nitrogen fertilizer. Hay and pasture crops respond to applications of phosphorus fertilizer. Use of manure provides organic matter and plant nutrients, helps increase intake of water, and improves tilth so that these soils can be worked more easily.

These soils are suited to irrigated pasture. Smooth gromegrass and orchardgrass are suitable pasture grasses. The addition of alfalfa or Alsike clover increases the value of the forage. In order to maintain production, pastures should be rotated and grazing should be limited so that a minimum of 4 inches of stubble is left on the soil. With good management and use of fertilizer, grass-legume mixtures can be used indefinitely for pasture or hay.

CAPABILITY UNIT IIIe–5 (IRRIGATED)

The one soil in this capability unit, Weld loamy sand, 1 to 4 percent slopes, is deep and well drained. It has a loamy sand surface layer and a clay and clay loam subsoil. Permeability is slow. Runoff is slow, and the hazard of soil blowing is high. Available water capacity is high. The effective rooting depth is 60 inches or more.

This soil is used for irrigated crops. Corn, alfalfa and small grain are the main crops. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn and a small grain. Row crops should be grown only if (1) crop residue is left on the ground during the windy period in winter and spring, or (2) a winter cover crop is established to protect the soil from blowing.

Sprinklers are the most effective method of irrigating this soil. The sprinklers should be self powered or easily removed because frequent irrigations are required.

Crops grown on this soil respond to fertilizer containing nitrogen and phosphorus. Use of crop residue and manure helps improve tilth.

This soil is well suited to permanent grass for pasture or hay. Smooth bromegrass and orchardgrass are suitable grasses. The addition of alfalfa or Alsike clover increases value of the forage. On the more nearly level areas borders can be used for irrigating hay and pasture. Irrigation runs should be short. Frequent, light irrigations are necessary. To maintain production, pastures should be rotated and grazing limited so that a minimum of 4 inches of stubble is left on the soil. With good management and use of fertilizer, pastures can be very productive.

CAPABILITY UNIT IIIe–6 (IRRIGATED)

This unit consists of deep, well-drained soils of the Ascalon, Manter, and Otero series. These soils have a sandy loam surface layer and a sandy loam or sandy clay loam subsoil or underlying layer. Slopes are 3 to 9 percent. Permeability is moderate to moderately rapid. Runoff is medium to rapid, and the erosion hazard is moderate or high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

The soils of this capability unit are used for irrigated crops. Their slope, however, is strong enough that row or vegetable crops should be planted only if alfalfa and small grain are used in the rotation to help reduce soil washing and soil blowing. Row crops should be limited to no more than 2 years in the rotation. Keeping tillage to a minimum helps reduce soil washing and blowing.

Flooding from contour ditches and sprinkling are suitable methods for irrigating drilled crops and pasture. Row crops can be irrigated by furrows, contour furrows, or sprinklers. Furrows should be angled across the slope to reduce the hazard of erosion. Irrigating with a small head of water and shortening the length of irrigation runs are ways to improve control of erosion.

These soils are well suited to permanent grass for hay or pasture. Smooth bromegrass, orchardgrass, or tall fescue are suitable grasses. The addition of Alsike clover or alfalfa increases value of the forage. To maintain production, frequent irrigations and applications of fertilizer containing nitrogen and phosphorus are necessary.

CAPABILITY UNIT IIIe–9 (IRRIGATED)

The one soil in this unit, Hargreave fine sandy loam, 1 to 3 percent slopes, is moderately deep and well drained. It has a surface layer of fine sandy loam and a subsoil of fine sandy clay loam. Permeability is moderate. Runoff is slow to medium, and the erosion hazard is moderate. Available water capacity is low to moderate. The effective rooting depth is between 20 and 40 inches.

This soil is used for crops and pasture. It is suited to limited cropping. A suitable cropping system is alfalfa followed by small grain. Where row crops are grown, they should be limited to no more than 2 years in the rotation, or rows should be slanted across the slope.

Most methods of irrigation are suitable, but irrigation runs should be short enough to avoid waterlogging the soil. Frequent, light irrigations are necessary.

This soil is best suited to permanent pasture. Brome, orchard, and fescue are suitable grasses. The addition of clover or alfalfa improves the value of the forage. Rotating grazing and limiting grazing are ways to maintain and improve the plant cover and help control erosion. Use of fertilizer improves yield.

CAPABILITY UNIT IIIw–1 (IRRIGATED)

This unit consists of deep, somewhat poorly drained soils of the Loveland series. These soils have a clay loam or sandy clay loam surface layer. The underlying layer is a sandy clay loam, clay loam, or loam that is 20 to 40 inches deep over gravelly sand. Slopes are 0 to 1 percent. Permeability is moderate. Runoff is slow, and the erosion hazard is slight. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 2 to 4 feet.

These soils can be used for irrigated crops (fig. 9). Yields, however, are lowered by the poor drainage. Salt-tolerant crops, such as barley and sugar beets, are especially well suited.

Irrigation systems should be designed to avoid overirrigation. The irrigation runs should be short. Frequent light irrigations help to minimize accumulation of salts and to prevent the excessive fluctuation in the water table that can be harmful to plants.

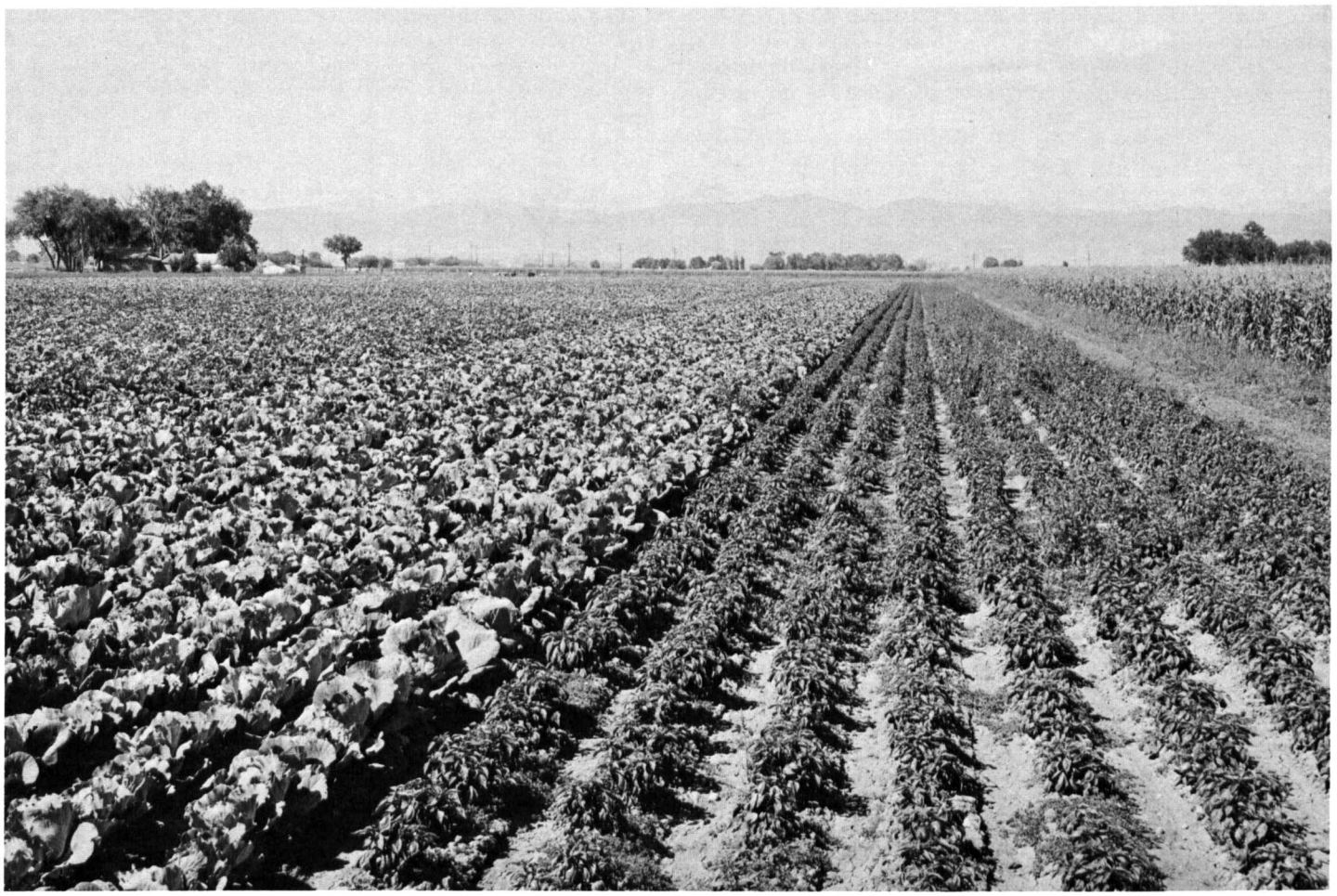

Figure 9.—**Pumpkins, cabbage, green peppers, and corn growing on Loveland soils.**

These soils are suited to pasture. Tall fescue, slender wheatgrass, or tall wheatgrass are suitable grasses. The addition of strawberry clover, yellowblossom sweetclover, or Alsike clover increases value of the forage. Proper management of pasture is necessary for sustained high yields.

CAPABILITY UNIT IVe–1 (IRRIGATED)

This unit consists of deep and moderately deep, moderately well drained and well drained soils of the Colby, Gaynor, Heldt, Kutch, Nunn, and Renohill series. These soils have a silty clay loam, clay loam, or clay surface layer. The subsoil or underlying layer is silty clay loam, clay loam, silty clay, or clay. Some of the soils are underlain by bedrock. Slopes are 3 to 9 percent. Permeability is moderate to slow. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 20 to 60 inches or more.

The soils of this capability unit are suited to limited cropping. Intensive cropping is hazardous because erosion is a hazard. Alfalfa and small grain are the main crops, but corn and sugar beets are also grown. Row crops should be limited to no more than 1 year in the rotation. A suitable cropping system is alfalfa for 3 or 4 years, followed by corn, small grain for 2 years, and alfalfa that is seeded with a nurse crop of small grain. Alfalfa for 3 or 4 years, followed by small grain for 2 years, is also a suitable cropping system. Suitable irrigation methods are limited. Sprinklers or closely spaced contour ditches are used for drilled crops. Row crops can be irrigated by contour furrows or sprinklers.

Seeding these soils to permanent grasses for pasture or hay is the best method of protecting them from erosion, and often this is the most profitable use. Smooth bromegrass and orchardgrass are suitable grasses. The addition of alfalfa or Alsike clover increases value of the forage. Pastures should be rotated, and grazing limited, so that a 4-inch stubble is left. Adequate water and sufficient fertilizer are needed to maintain vigorous pasture that protects the soils from erosion. Permanent contour ditches or sprinklers can be used for pasture, so that irrigation is less costly than for field crops.

Soil tilth and fertility can be maintained by applying manure. Use of commercial fertilizer helps promote growth of the vegetation so necessary in reducing the hazard of erosion.

CAPABILITY UNIT IVe–2 (IRRIGATED)

The one soil of this capability unit, Hargreave fine sandy loam, 3 to 9 percent slopes, is moderately deep and well drained. This soil has a surface layer of fine sandy loam and a subsoil of fine sandy loam and sandy

clay loam that is underlain by sandstone. Permeability is moderate. Runoff is slow to rapid, and the erosion hazard is moderate to high. Available water capacity is low to moderate. The effective rooting depth is 20 to 40 inches.

This soil is suited to limited cropping. A suitable cropping system is alfalfa for 3 or 4 years and small grain for 1 or 2 years. If row or vegetable crops are grown, they should be limited to no more than 2 years in the cropping sequence. Where row or vegetable crops are grown, the rows should be slanted across the slope.

Suitable methods for irrigating this soil are limited. Closely spaced contour furrows or sprinkling are the most suitable. Frequent light irrigations are necessary because the available water capacity is limited. Light irrigations minimize the possibility of perching water on the underlying sandstone.

This soil is best suited to permanent pasture. Smooth bromegrass and orchardgrass are suitable grasses. The addition of Alsike clover or alfalfa increases the value of the forage. Pastures should be rotated, and grazing limited, so that a minimum of 3 inches of stubble is left on the soil. Application of fertilizer containing nitrogen and phosphorus is necessary for high yields, as is adequate water.

CAPABILITY UNIT IVe-3 (IRRIGATED)

This unit consists of deep, well-drained soils of the Ascalon and Otero series. These soils have a sandy loam surface layer and a subsoil or underlying layer of sandy loam or sandy clay loam. Slopes are 5 to 9 percent. Permeability is moderate or moderately rapid. Runoff is rapid, and the erosion hazard is high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

The soils of this capability unit are suited to some of the crops commonly grown in the Area. A suitable cropping system is alfalfa for 3 or 4 years rotated with small grain for 2 years. Row cropping should be limited, and if row crops are grown, the furrows should be angled across the slope.

Suitable methods for irrigating are limited. Closely spaced contour furrows and sprinkling are the most suitable. Extreme care must be taken in irrigating in order to minimize the losses resulting from erosion.

Seeding these soils to permanent grasses for pasture or hay is the best method of protecting them from erosion. Smooth bromegrass and orchardgrass are suitable grasses. The addition of alfalfa or Alsike clover increases value of the forage. Pastures should be rotated, and grazing limited, to allow vigorous plant growth and reduce the hazard of erosion. Adequate water and fertilizer are needed to maintain vigorous pasture that can protect the soils from erosion.

CAPABILITY UNIT IVs-1 (IRRIGATED)

This unit consists of moderately deep, well-drained soils of the Gaynor and Renohill series. These soils have a silty clay loam surface layer. The subsoil or underlying layer is a silty clay loam or silty clay that is underlain by bedrock. Slopes are 1 to 3 percent. Permeability is moderate to slow. Runoff is medium, and the erosion hazard is moderate. Available water capacity is moderate to high. The effective rooting depth is 20 to 40 inches.

The soils of this capability unit are suited to limited cropping. A suitable cropping system is alfalfa for 3 or 4 years or longer, corn, small grain for 2 years, and a row crop. Intensive row or vegetable cropping is hazardous because of the hazard of erosion and the depth to bedrock.

Use of plant residue improves tilth so that the soils can be worked more easily. Feedlot manure is especially good because it provides organic matter and plant nutrients.

Most methods of irrigation are suited to these soils, but irrigation runs should be short enough to avoid both overirrigation and waterlogging of the soils. Frequent light irrigations are necessary.

These soils are suited to permanent grass for hay or pasture. Tall wheatgrass and smooth bromegrass are suitable. The addition of Alsike clover or alfalfa increases value of the forage. Pastures need intensive management to maintain plant vigor. Pastures should be rotated, and grazing limited, so that a minimum of 3 inches of stubble is left on the soil. Commercial fertilizer adds to the amount and value of the forage produced. With adequate water and good management, planting these soils to pasture or hay will improve their tilth.

CAPABILITY UNIT IVw-1 (IRRIGATED)

This unit consists of deep, somewhat poorly drained soils of the Niwot series. These soils have a surface layer of loam, sandy clay loam, or clay loam that is 10 to 20 inches deep over gravelly sand. Slopes are 0 to 1 percent. Permeability is moderate. Runoff is slow, and the erosion hazard is slight. Available water capacity is low or moderate. The effective rooting depth is 60 inches or more A seasonal high water table is at a depth of ½ to 1½ feet.

Included in this unit is Made land that is composed of waste material from sugar factories. Some areas have been seeded to grass and are irrigated. Made land is not suited to dryland cropping and should remain under a permanent cover of grass.

The soils of this capability unit are suited to very limited cropping. Water-tolerant crops are especially suitable. Because they are droughty, it is not practical to drain these soils. Frequent light irrigations minimize accumulations of salts. Leveling that requires deep cuts is not suitable because it exposes the underlying droughty gravelly sand. Some smoothing is helpful in controlling flow of irrigation water.

These soils are best suited to permanent grasses for hay or pasture. Tall wheatgrass, tall fescue, or yellowblossom sweetclover are suitable for pasture. Pastures should be rotated and grazing limited so that a minimum of 3 inches of growth is left on the soil. When high water is flowing in stream channels, protection of streambanks is necessary to avoid erosion. Commercial fertilizer improves amount and value of the forage produced.

CAPABILITY UNIT Vs-1 (IRRIGATED)

The one soil in this capability unit, Valmont cobbly clay loam, 1 to 5 percent slopes, is deep and well drained. This soil has a cobbly clay loam surface layer and a subsoil of clay or clay loam that is 20 to 40 inches deep over very gravelly or cobbly materials. Permeability is moderate. Runoff is medium, and the erosion hazard is slight

to moderate. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches.

The soil of this capability unit is used mainly for irrigated pasture because it is too cobbly for continuous cultivation. It is best used for permanent pasture for hay or grass. Smooth bromegrass, tall wheatgrass, and orchardgrass are suitable grasses. The addition of alfalfa or Alsike clover adds to the value of the forage. Seeding this soil is difficult because the cobbles can break up the seeder. Broadcast seeding and dragging to cover the seed is sometimes successful.

Irrigation can be difficult because the available water supply is limited and frequent irrigations are needed. Often, this soil is irrigated with tail or waste water, and when water is scarce, it is not irrigated at all. Suitable methods of irrigation are sprinkling and flooding from contour ditches. Erosion is not a serious hazard on this soil.

Pastures should be rotated and grazing limited so that a minimum of 3 inches of stubble is left on the soil. Commercial fertilizers increase the amount and value of the forage produced, but fertilizing should be based on the available water supply.

Predicted Yields of Principal Irrigated Crops

Predicted yields for the principal crops grown in the Area are given in table 2. Yields shown represent those obtained by the leading commercial farmers. Although estimates are given for only the major crops, the practices required to achieve a high crop yield for any other crop adapted to the Area are similar.

To achieve the yields indicated for alfalfa, certified seed of the best-adapted variety should be used. The seedbed should be properly prepared and planting done at the right time so as to obtain good germination. New

TABLE 2.—*Predicted average acre yields of principal irrigated crops*

[Listed in this table are only those soils on which significant yields of one or more of the principal crops are obtained. Absence of a yield figure indicates that the crop specified is not normally grown on the soil]

Soil	Alfalfa	Sugar beets	Corn	Barley
	Tons	*Tons*	*Bu.*	*Bu.*
Ascalon sandy loam, 0 to 1 percent slopes	6.0	24	125	90
Ascalon sandy loam, 1 to 3 percent slopes	5.5	24	110	80
Ascalon sandy loam, 3 to 5 percent slopes	4.5	19	90	65
Ascalon sandy loam, 5 to 9 percent slopes	4.0		85	55
Ascalon-Otero complex, 0 to 3 percent slopes	5.5	24	110	80
Ascalon-Otero complex, 3 to 5 percent slopes	4.0	17	85	60
Ascalon-Otero complex, 5 to 9 percent slopes	3.5			50
Calkins sandy loam, 0 to 1 percent slopes	5.5	21	100	80
Calkins sandy loam, 1 to 3 percent slopes	5.0	21	100	80
Colby silty clay loam, 1 to 3 percent slopes	5.5	24	110	85
Colby silty clay loam, 3 to 5 percent slopes	4.5	18	90	75
Colby silty clay loam, 5 to 9 percent slopes	4.0		70	55
Colby silty clay loam, wet, 0 to 3 percent slopes	4.5	21	100	85
Colby-Gaynor association	4.0			55
Gaynor silty clay loam, 1 to 3 percent slopes	4.5	19	90	85
Gaynor silty clay loam, 3 to 9 percent slopes	4.0		70	65
Hargreave fine sandy loam, 1 to 3 percent slopes	4.5	19	90	85
Hargreave fine sandy loam, 3 to 9 percent slopes	4.0		75	65
Heldt clay, 0 to 3 percent slopes	4.0	16	60	80
Heldt clay, 3 to 5 percent slopes	3.5	14	55	65
Kutch clay loam, 3 to 9 percent slopes	4.0		70	55
Loveland soils	5.0	20	90	70
Manter sandy loam, 0 to 1 percent slopes	5.5	22	110	75
Manter sandy loam, 1 to 3 percent slopes	5.0	22	100	75
Manter sandy loam, 3 to 9 percent slopes	4.0	17	75	55
Manvel loam	5.0	20	100	80
McClave clay loam	5.0	21	100	80
Nunn sandy clay loam, 0 to 1 percent slopes	6.0	25	125	90
Nunn sandy clay loam, 1 to 3 percent slopes	6.0	24	120	90
Nunn clay loam, 0 to 1 percent slopes	5.5	24	120	90
Nunn clay loam, 1 to 3 percent slopes	5.5	23	110	90
Nunn clay loam, 3 to 5 percent slopes	4.0	18	90	75
Nunn clay loam, 5 to 9 percent slopes	3.5			65
Nunn-Kim complex	5.5	23	110	90
Renohill silty clay loam, 1 to 3 percent slopes	4.0	19	90	85
Renohill silty clay loam, 3 to 9 percent slopes	4.0		70	70
Valmont clay loam, 1 to 3 percent slopes	4.5	19	100	90
Valmont clay loam, 3 to 5 percent slopes	4.0		75	75
Weld loamy sand, 1 to 4 percent slopes	5.0		110	75
Weld fine sandy loam, 1 to 3 percent slopes	6.0	24	120	90
Weld loam, 0 to 1 percent slopes	6.0	25	125	90
Weld loam, 1 to 3 percent slopes	6.0	24	120	90
Weld-Colby complex, 0 to 3 percent slopes	5.0	22	120	90
Weld-Colby complex, 3 to 5 percent slopes	4.0	18	90	75

fields or fields that have not been in alfalfa for several years may need to be sown with seeds innoculated with nitrogen-fixing bacteria. Since alfalfa is usually planted with a nurse crop, the stand for the nurse crop should not be so thick as to choke out the alfalfa, nor should the field be too dry at the beginning of the winter, because either affects the stand of alfalfa obtained. Application of fertilizers, particularly those containing phosphorus, is necessary at the time of seeding, as is mechanical and chemical control of insects, diseases, and weeds. Timeliness of the harvest is important for both the quality and quantity of the alfalfa.

To achieve the yields indicated for sugar beets, the varieties recommended by the sugar company should be used. In order to prepare a good seedbed, plowing the field in the fall is desirable. Planting at the right time will help obtain good germination. Thinning and blocking should be done properly in order to assure a uniform stand and the optimum number of plants per acre. Application of fertilizers, particularly those containing phosphorus, is necessary, as is mechanical and chemical control of insects, diseases, and weeds.

To achieve the yields indicated for corn, certified seed of the best adapted variety for the purpose intended, either as grain or as silage, should be used. Seeding at a rate that produces optimum number of plants per acre is also important. Application of fertilizer, particularly nitrogen, at planting time and through the growing season is necessary. Chemical and mechanical control of weeds and insects may be necessary.

To achieve the yields indicated for barley, it is grown after a cultivated crop such as corn, sugar beets, or beans. Plowing, followed by disking, floating, and harrowing, is used in seedbed preparation. Cool-weather seeding, April 1 to April 20, and high quality seed are needed. No special fertilization is necessary. One irrigation applied between the jointing and heading stages is generally sufficient.

It is necessary to manage irrigation water for optimum growth of all plants. Water must be applied at the proper time and in the right amount so that plants are not subjected to shortage of water or waterlogging. Leveling, drainage, and erosion control must be carried out as appropriate. Timeliness of any farming practice is important. A systematic crop rotation assists (1) in maintaining good tilth, aeration, and permeability of the soil; (2) in controlling insects, weeds, and diseases; and (3) in minimizing annual work loads and the need for machinery.

Management of Nonirrigated Soils

About 25,000 acres in the Boulder Area is dry cropland. Most of this is in small acreages scattered throughout the eastern part. In the main dryfarmed area the mean annual precipitation ranges from 12 to 18 inches, but it is as high as 24 inches in the mountains. The frost-free period in the main dryfarmed areas is 140 to 155 days, which is more than enough to mature winter grain. It is as low as 80 days in the mountains. Included in the acreages used mainly for dryland crops are areas that can be irrigated in years when water is plentiful.

Since most of the Boulder Area receives limited precipitation, a system of summer fallow is used on dryland soils to store moisture during the fallow period and make it available for crops during the following year. In the fallow period, weeds and volunteer crops are destroyed by sweeps or other machines that leave part of the stubble on the surface. This stubble helps to keep the soils from crusting and reduces erosion. Minimum tillage also helps to keep crop residues on the surface where they protect the soils from blowing and water erosion.

Stripcropping helps reduce erosion. The strips are of varying width, according to the kind of soil. These strips are usually at right angles to the direction of the prevailing strong wind, which is mostly west-east or east-west. Contour stripcropping is another way of conserving winter moisture.

If there is not enough stubble to protect the soil from blowing, emergency tillage may be necessary. In this practice, implements are used that bring clods to the surface. The rough surface helps reduce losses by blowing soil.

The main cropping system on dryland is one in which winter wheat is alternated with summer fallow. The fields are cropped mostly in strips that alternate with strips that are stubble-mulch fallowed.

Grassed waterways are used effectively to carry excess surface runoff.

CAPABILITY UNIT IIIe-7 (NONIRRIGATED)

This unit consists of deep, well-drained soils of the Nunn, Valmont, Weld, and Colby series. Most of these soils have a fine sandy loam to clay loam surface layer and a silty clay loam or clay subsoil. Slopes are 3 to 5 percent. Permeability is slow to moderate. Runoff is rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

These soils are used mainly as dry cropland. A suitable cropping system is wheat-summer fallow. The stubble should be left standing through winter and spring to help reduce soil blowing and water erosion. Stubble-mulch tillage helps to reduce erosion and to collect snow. Stripcropping at right angles to the direction of prevailing wind reduces soil blowing (fig. 10).

These soils are suited to grass for pasture. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and Russian wildrye are suitable pasture grasses. To insure a full and vigorous stand of grasses, grazing should be limited until the grass has become established.

CAPABILITY UNIT IIIe-8 (NONIRRIGATED)

This unit consists of deep or moderately deep, well-drained soils of the Ascalon, Hargreave, Manter, Otero, and Weld series. The soils have a sandy loam and fine sandy loam surface layer and a subsoil or underlying layer of sandy loam, sandy clay loam, or clay. Slopes are 0 to 3 percent. Permeability is slow to moderately rapid. Runoff is slow to medium, the hazard of water erosion is slight to moderate, and the hazard of soil blowing is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

These soils are used mainly as dry cropland, although a few areas are in pasture. Wheat is the main crop, but other small grains are also grown. Because of the limited precipitation, a system of summer fallow is necessary for maintaining yields. During fallow periods, it is im-

Figure 10.—**Stripcropping on Weld-Colby complex, 3 to 5 percent slopes.**

portant to keep plant residues on the surface to aid in controlling soil blowing (fig. 11).

If there is sufficient moisture, the use of nitrogen fertilizer increases vigor of the crops.

Crested wheatgrass, pubescent wheatgrass, intermediate wheatgrass, and Russian wildrye are well adapted grasses suitable for planting. Planting in grain stubble helps conserve moisture and reduces soil blowing. To insure a full and vigorous stand, newly seeded areas should not be grazed during the first growing season. After the stand has been established, grazing should be limited so that a minimum of 3 inches of stubble is left.

Natural drainageways can be protected from water erosion by planting grass (fig. 12).

CAPABILITY UNIT IIIs-1 (NONIRRIGATED)

This unit consists of deep, well-drained soils of the Nunn and Valmont series. These soils have a clay loam surface layer and a clay or clay loam subsoil. Slopes are 1 to 3 percent. Permeability is moderate to slow. Runoff is medium, and the erosion hazard is moderate. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

These soils are used mainly as dry cropland and pasture. Wheat is the main crop, but other small grains are also grown. A system of summer fallow is used to store moisture during the fallow period and make it available for crops during the following year. Stubble mulching is helpful in reducing erosion, in maintaining the content of organic matter, and in improving tilth. Terracing and stripcropping also help control erosion.

Some areas of these soils are used as range. Russian wildrye, crested wheatgrass, pubescent wheatgrass, and intermediate wheatgrass are adapted grasses suitable for seeding. To insure a full and vigorous stand, newly seeded areas should not be grazed during the first growing

Figure 11.—Hummocks caused by soil blowing in an unprotected field of Ascalon sandy loam, 1 to 3 percent slopes.

season. After the stand has been established, grazing should be limited so that a minimum of 3 inches of stubble is left. No more than one-half of the current year's growth of grasses should be grazed.

CAPABILITY UNIT IIIc-1 (NONIRRIGATED)

This unit consists of deep, well-drained soils of the Weld and Colby series. These soils have a loam or silty clay loam surface layer, and a silty clay loam, clay loam, or clay subsoil or underlying layer. Slopes are 0 to 3 percent. Permeability is moderate to slow. Runoff is slow to medium, and the erosion hazard is slight to moderate. Available water capacity is high. The effective rooting depth is 60 inches or more.

These soils are used mainly as dry cropland. Wheat is the main crop, but other small grains are also grown. The major management problem is conservation of moisture. Wheat-summer fallow is the main cropping system. During the fallow period, weeds can be destroyed by using chisels and sweeps that leave part of the stubble on the surface. The weed stubble protects the soil from blowing and water erosion. Stubble mulching is helpful in conserving moisture and reducing the hazard of erosion. Terraces and contour stripcropping also help control erosion.

An alternate use for the soils of this unit is as pasture. Russian wildrye, crested wheatgrass, pubescent wheatgrass, and intermediate wheatgrass are suitable grasses. Proper management of pasture is necessary to obtain and maintain a stand.

CAPABILITY UNIT IVe-4 (NONIRRIGATED)

This unit consists of deep and moderately deep, well drained and moderately well drained soils of the Colby, Gaynor, Heldt, Manvel, or Renohill series. These soils have a surface layer and subsoil or underlying layer of

Figure 12.—**Waterway sodded with wheatgrasses on Ascalon sandy loam, 1 to 3 percent slopes.**

loam, silty clay loam, or clay. Slopes range from 0 to 3 percent. Permeability is moderate to slow. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 20 to 60 inches or more.

These soils are used mainly as dry cropland and pasture. Because of the erosion hazard and the slow rate of water intake, these soils are suitable for only limited cropping. Wheat is the main crop, but other small grains are also grown. Wheat-summer fallow is the main cropping system. During the fallow period, weeds can be destroyed by using chisels and sweeps that leave part of the stubble on the surface. Leaving stubble on the soil through winter and spring helps to trap snow and to control soil blowing. Stripcropping also helps control erosion, especially soil blowing.

These soils are well suited to pasture. Where they are in native grasses, they should remain so and not be plowed and reseeded. Where they are to be seeded to grass, grasses suitable for seeding are crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and Russian wildrye. Where the soils are seeded, planting in stubble will increase the survival rate of seedlings and help control erosion. In order to insure the establishment of the stand, grazing should not be allowed during the first year. Proper grazing practices are necessary.

CAPABILITY UNIT IVe-7 (NONIRRIGATED)

This unit consists of deep, well-drained soils of the Ascalon, Manter, and Otero series. These soils have a sandy loam surface layer and a sandy loam or sandy clay loam subsoil or underlying layer. Slopes are 3 to 9 percent. Permeability is moderate and moderately rapid. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 60 inches or more.

These soils are used as dry cropland and pasture. Wheat is the main crop, but other small grains are also grown. Wheat-summer fallow is the main cropping system. Stubble mulching and stripcropping are helpful in reducing erosion. Terracing and contour farming help control soil blowing and water erosion.

These soils are well suited to grasses. Where they are in native grass, they should remain so. Russian wildrye, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are adapted grasses suitable for seeding. Planting in stubble helps conserve moisture, control erosion, and increase the content of organic matter.

CAPABILITY UNIT IVe-9 (NONIRRIGATED)

The one soil in this unit, Weld loamy sand, 1 to 4 percent slopes, is deep and well drained. It has a surface layer of loamy sand and a subsoil of clay or clay loam. Permeability is slow. Runoff is slow, and the erosion hazard is high. Soil blowing is the greatest hazard. Available water capacity is high. The effective rooting depth is 60 inches or more.

This soil is used as dry cropland and pasture. It is suited to limited cropping. Wheat is the main crop, but other small grain is also grown. Wheat-summer fallow is the main cropping system. Stubble mulching and management of crop residue are necessary to help control erosion and soil blowing. The soil should not be left bare for long periods, because the hazard of soil blowing is high. If emergency tillage is necessary, the clayey subsoil material should be brought to the surface.

This soil is suited to permanent grass pasture. Russian wildrye, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are well adapted grasses that can be seeded. Seeding in the stubble helps control soil blowing. To insure a full and vigorous stand, newly seeded pasture should not be grazed during the first growing season.

CAPABILITY UNIT VIe-1 (NONIRRIGATED)

This unit consists of deep and moderately deep, well drained and moderately well drained soils of the Colby, Gaynor, Heldt, Kutch, Nunn, and Renohill series. These soils have a surface layer and subsoil or underlying layer of silty clay loam, clay loam, or clay. Slopes are 3 to 9 percent. Permeability is moderate to slow. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 20 to 60 inches or more.

These soils are used as dry cropland, pasture, and range. They are best used as pasture. Because of their slope, these soils are difficult to work. They do not take water in readily, and this results in excessive losses through erosion. Where these soils are now farmed, they should be seeded back to grass. Blue grama and the needlegrasses are native. Russian wildrye, crested wheatgrass, pubescent wheatgrass, and intermediate wheatgrass are adapted species. Smooth bromegrass does well, but only in areas that receive extra moisture as runoff from higher lying soils.

Proper management of pasture is necessary. Grazing should be limited so that no more than half of the current year's growth is grazed. To insure a full and vigorous stand, newly seeded grasses should not be grazed during the first growing season. After the stand has been established, grazing should be limited so that a minimum of 3 inches of stubble is left.

CAPABILITY UNIT VIe-2 (NONIRRIGATED)

This unit consists of deep and moderately deep, well-drained soils of the Ascalon, Hargreave, and Otero series. These soils have a sandy loam or fine sandy loam surface layer. The subsoil or underlying layer is sandy loam, sandy clay loam, or fine sandy clay loam. Slopes are 3 to 20 percent. Permeability is moderate to moderately rapid. Runoff is medium to rapid, and the erosion hazard is moderate to high. Available water capacity is moderate to high. The effective rooting depth is 20 to 60 inches or more.

These soils are used as dry cropland, pasture, or range. Because of their slope, continued tillage of these soils results in excessive erosion. These soils are best used as pasture or range. Big bluestem, little bluestem, switchgrass, indiangrass, and side-oats grama are native grasses. Those areas that now support crops or depleted stands of native grasses can be planted to introduced grasses. Russian wildrye, crested wheatgrass, pubescent wheatgrass, and intermediate wheatgrass are well adapted species.

Proper management of pasture is necessary. Grazing should be limited so that no more than half of the current year's growth is grazed. To insure a full and vigorous stand, newly seeded grasses should not be grazed during the first growing season. After the stand has been established, grazing should be limited so that a minimum of 3 inches of stubble is left.

CAPABILITY UNIT VIe-3 (NONIRRIGATED)

This unit consists of shallow and moderately deep, well-drained soils of the Laporte, Gaynor, Renohill, Samsil, and Shingle series. These soils have a very fine sandy loam, loam, silty clay loam, or clay surface layer. The underlying layer is loam, silty clay loam, or clay. Slopes are 3 to 25 percent. Permeability is moderate to slow. Runoff is medium to rapid, and the erosion hazard is high. Available water capacity is low to moderate. The effective rooting depth is 10 to 40 inches.

These soils are used as dry cropland, pasture, or range. Ordinarily they are best used as permanent pasture or range. The needlegrasses, western wheatgrass, and needleandthread are suitable grasses. If these soils are in native range, they should be plowed only to reestablish stands of grass that have become depleted. To improve yield and quality of forage, range should be rotated and grazing deferred, so that no more than half of the current year's growth is removed.

Where these soils are seeded to pasture, planting should be in early spring or fall when there is adequate moisture. Russian wildrye, crested wheatgrass, and intermediate wheatgrass are well adapted species. To insure a full and vigorous stand, newly seeded grasses should not be grazed during the first growing season. Grazing should be limited so that a minimum of 3 inches of stubble is left on the soil.

CAPABILITY UNIT VIw-1 (NONIRRIGATED)

The one soil in this unit, Longmont clay, 0 to 3 percent slopes, is deep and poorly drained. It has a surface layer and underlying layer of clay. Permeability is slow.

Runoff is slow, and the erosion hazard is slight. Available water capacity is high. The effective rooting depth is 12 to 14 inches or more, and the seasonal high water table is at a depth of between 1 and 2 feet.

This soil is best suited to pasture. Where the pasture is in excellent condition, the dominant grasses are switchgrass, alkali sacaton, and western wheatgrass. Good management of pasture is necessary. When the soil is extremely wet, grazing should be limited to avoid compaction and trampling out the grass. To maintain the vigor of the grasses, no more than half of the current year's growth should be grazed.

Reseeding this soil is difficult because it is seldom dry enough to cultivate and is hard to work. Areas that are sufficiently dry can be disked and seeded. Tall wheatgrass or tall fescue are adapted grasses suitable for seeding. Grazing should not be allowed until the grass is well established.

CAPABILITY UNIT VIw–2 (NONIRRIGATED)

The one soil in this unit, Niwot soils, is deep and somewhat poorly drained. It has a surface layer of loam or clay loam that is shallow over an underlying layer of sand or gravel. Slopes are 0 to 1 percent. Permeability is moderate. Runoff is slow, and the erosion hazard is slight. Available water capacity is low to moderate. The effective rooting depth is 60 inches or more, and the seasonal high water table is between a depth of 6 and 18 inches.

These soils are used mainly for pasture. They are best suited to permanent vegetation. The dominant pasture grasses are indiangrass, switchgrass, big bluestem, and little bluestem. Intermediate wheatgrass, tall wheatgrass, or tall fescue are adapted grasses suitable for seeding. Where these soils are seeded, planting in stubble early in spring or in fall increases the survival rate of seedlings and helps produce a vigorous stand. To maintain the vigor of the grasses, no more than half of the current year's growth should be grazed.

CAPABILITY UNIT VIIe–1 (NONIRRIGATED)

This unit consists of deep and moderately deep, well-drained soils of the Allens Park, Fern Cliff, Goldvale, and Pinata series. These soils have a stony coarse loamy sand, loamy sand, sandy loam, or gravelly sandy loam surface layer. The subsoil or underlying layer is gravelly sandy loam, sandy loam, gravelly sandy clay loam, sandy clay loam, or sandy clay. Slopes are 5 to 60 percent. Permeability is slow to moderately rapid. Runoff is medium to rapid, and the erosion hazard is high. Available water capacity is low to high. The effective rooting depth is 20 to 60 inches or more.

These soils are used mainly as woodland. They are also used as a habitat for wildlife. Proper management of both the timber and understory helps reduce possible erosion. Wooded areas should be protected from fire and insects and from plant diseases. Thinning of timber improves the quality and quantity of trees.

A few areas of the woodland are used for grazing of the understory vegetation. No more than half of the current year's growth of vegetation should be grazed. Where grazing is properly managed, such grasses as Arizona fescue, mountain muhly, and pine dropseed increase. Seeding of grasses is not practical because of the slope, rock outcrop, and the amount of trees and stones.

CAPABILITY UNIT VIIs–1 (NONIRRIGATED)

This unit consists of shallow to deep, well-drained soils of the Baller, Juget, Nederland, Peyton, Sixmile, and Valmont series, and of Terrace escarpments and Colluvial land. These soils have a very cobbly sandy loam, very stony loamy sand, very gravelly loamy sand, stony fine sandy loam, very gravelly sandy loam, stony loam, or cobbly clay loam surface layer. The subsoil is very gravelly loamy sand, stony fine sandy loam, very cobbly sandy clay loam, very stony clay, clay, or clay loam. Depth to bedrock ranges from 10 to 60 inches or more. Slopes are 1 to 55 percent. Permeability is moderately slow to rapid. Runoff is slow to rapid, and the erosion hazard is slight to high. Available water capacity is low to high. The effective rooting depth is 10 to 60 inches or more.

These soils are used as range and as habitat for wildlife. They are suited to permanent vegetation. Suitable grasses are big bluestem, little bluestem, needlegrass, and side-oats grama. Proper management of range is necessary. To maintain the vigor of the grasses and to reduce erosion, no more than half of the current year's growth should be grazed. Reseeding these soils is difficult, and in some places impossible, because of the slope, rock outcrops, and amount of stones, cobblestones, and gravel.

CAPABILITY UNIT VIIIs–1 (NONIRRIGATED)

In this capability unit are Rock outcrop and Made land.

Rock outcrop consists of areas of bare or nearly bare rock and adjacent areas of very shallow soil material that has little or no agricultural value. Since most areas of Rock outcrop have little soil, runoff is very rapid and causes erosion of nearby soils. Most areas of Rock outcrop are in the mountains and provide a habitat for wildlife. Some areas are parks where there are trails and opportunities for nature studies, hiking, and climbing. These areas are used also for watershed purposes. Areas of Rock outcrop should be protected to maintain what little vegetation is present. Trails should be constructed and maintained so that water from runoff does not concentrate. This practice helps control erosion on adjacent soils.

Made land consists of refuse from sugar mills. Unless water is available for both irrigation and leaching of salts, this land is barren.

Predicted Yields of Principal Dryland Crops

Predicted yields per acre for crops grown without irrigation are given in table 3. Since there is limited production of dryland crops in the Area, wheat and barley are the only crops for which yields are given. Minor acreages of sorghum, oats, and dry beans are grown, however. Since the wheat and barley are grown mainly on land that is fallowed every other year, only the year that the crops were seeded was considered in predicting yields.

Following are management practices to be applied to obtain optimum yields. Seed of good quality and suitable variety is used. Planting is done at the proper time and at a rate that helps control disease and produces a good stand. Summer fallowing is done to conserve moisture and control weeds. Crop residues are kept on the

soil to maintain fertility and tilth, control erosion, and increase infiltration of water. Stripcropping, contour farming, terracing, grassed waterways, and minimum tillage are used, as appropriate, to reduce erosion and thereby maintain productivity. Chemical and mechanical control of weeds, diseases, and insects is practiced. Fertilizer, particularly nitrogen, is applied in years when moisture is plentiful. The foregoing practices are done at the time they are most effective.

The yields in table 3 are based on field observations and on discussions with farmers; on information from the Boulder County Extension Agent and other agricultural specialists in the Area; and on statistics from the Colorado Cropland Livestock Reporting Service.

TABLE 3.—*Predicted average acre yields of principal nonirrigated crops*

[The only soils listed are those on which significant yields of one or more crops are obtained]

Soil	Wheat	Barley
	Bu.	*Bu.*
Ascalon sandy loam, 1 to 3 percent slopes	19	20
Ascalon sandy loam, 3 to 5 percent slopes	18	19
Ascalon sandy loam, 5 to 9 percent slopes	14	14
Ascalon-Otero complex, 0 to 3 percent slopes	18	18
Ascalon-Otero complex, 3 to 5 percent slopes	17	17
Colby silty clay loam, 1 to 3 percent slopes	15	16
Gaynor silty clay loam, 1 to 3 percent slopes	15	16
Hargreave fine sandy loam, 1 to 3 percent slopes	19	20
Heldt clay, 0 to 3 percent slopes	15	15
Manter sandy loam, 1 to 3 percent slopes	19	20
Manter sandy loam, 3 to 9 percent slopes	16	17
Manvel loam	15	16
Nunn clay loam, 1 to 3 percent slopes	19	20
Nunn clay loam, 3 to 5 percent slopes	18	19
Renohill silty clay loam, 1 to 3 percent slopes	15	16
Valmont clay loam, 1 to 3 percent slopes	19	20
Valmont clay loam, 3 to 5 percent slopes	18	19
Weld loamy sand, 1 to 4 percent slopes	18	19
Weld fine sandy loam, 1 to 3 percent slopes	19	20
Weld loam, 1 to 3 percent slopes	19	20
Weld-Colby complex, 0 to 3 percent slopes	17	18
Weld-Colby complex, 3 to 5 percent slopes	15	17

Native Grassland [3]

In the Boulder Area about 15 percent of the total acreage is covered with grass. The total area now grazed is small, compared to the extensive areas once grazed in the early days of Colorado history. The decrease is partly the result of converting grassland to irrigated cropland, or to use for homes, industry, and recreation.

Soils of the Boulder Area are suited to many kinds of native grasses, shrubs, and other forage plants, but individual soils of the Area differ in their suitability for specific kinds of plants. The names of important plant species suited to the individual soils in the Area are given in the section of this survey where capability units are described.

Where plants are used for grazing, they need to be managed in a way that improves quality and quantity of the desired forage and that produces enough residue to protect the soils and preserve moisture. Important in range management is the ability to recognize the main forage plants; to be aware of the approximately yield per acre of such plants; and to be aware of the number of livestock any given area can support. For most grasses, a proper rate of grazing is one that allows not more than 50 percent, by weight, of the season's growth to be grazed.

In the Boulder Area, other good management practices include deferred grazing, reseeding to adapted plants, and protecting areas from fire, traffic, and other kinds of disturbances.

Deferred grazing consists of resting pasture or rangeland during the growing season. This increases the vigor of the plants, permits the desired plants to reproduce naturally by seed, and builds up a reserve of forage. When this practice is used, along with the other practices suggested, the maximum amount of forage is produced and livestock makes the greatest gains (fig. 13).

In addition to their value for grazing for domestic livestock, native grasses protect soils from blowing by wind and from erosion by water. Streams and lakes are kept clean when the watersheds above them have a good plant cover. Finally, there is the natural beauty grassland contributes.

Woodland and Tree Planting [4]

Native woodland in the Boulder Area is in a transitional zone between the plains and the mountains. Largely it is fringe forest growing at lower elevation and in a drier climate than the true forest. Practically all this woodland is in the Rock outcrop-Juget-Baller association.

The dominant species is ponderosa pine, which grows mainly on the Goldvale, Pinata, Juget, Fern Cliff, and Allens Park soils. A narrow fringe of pinyon pine and Rocky Mountain juniper grows mainly on Baller stony sandy loam, 9 to 35 percent slopes. Around Gold Hill and at elevations of above 8,000 feet there are some Douglas-firs and lodgepole pines. In some places these two species grow separately, but in other places they are in mixed stands. These two species grow mainly on Fern Cliff and Allens Park soils.

Douglas-fir is usually considered the climax, or original, forest type of the Area. Lodgepole pine is normaly considered a "fire type," meaning it comes in following fire or heavy clearing of the climax species. Because of heavy cutting during the boom days of mining, much of the original Douglas-fir forest had been cut over or burned before 1900. The present stands of lodgepole pine came in after cutting. In all, there is less than 2,000 acres of the Douglas-fir and lodgepole pine type of woodland in the survey area.

Most of the forested land in the Boulder Area is used for homesites, rather than for wood production, grazing, or watershed. Both year-round homes and summer homes in the woods are growing in popularity in the Area. It is anticipated that practically all of the wooded areas outside of Roosevelt National Forest and in private ownership eventually will be used for homesites and recreation.

[3] By T. K. EAMAN, range conservationist, Soil Conservation Service.

[4] By W. S. SWENSON, woodland conservationist, Soil Conservation Service.

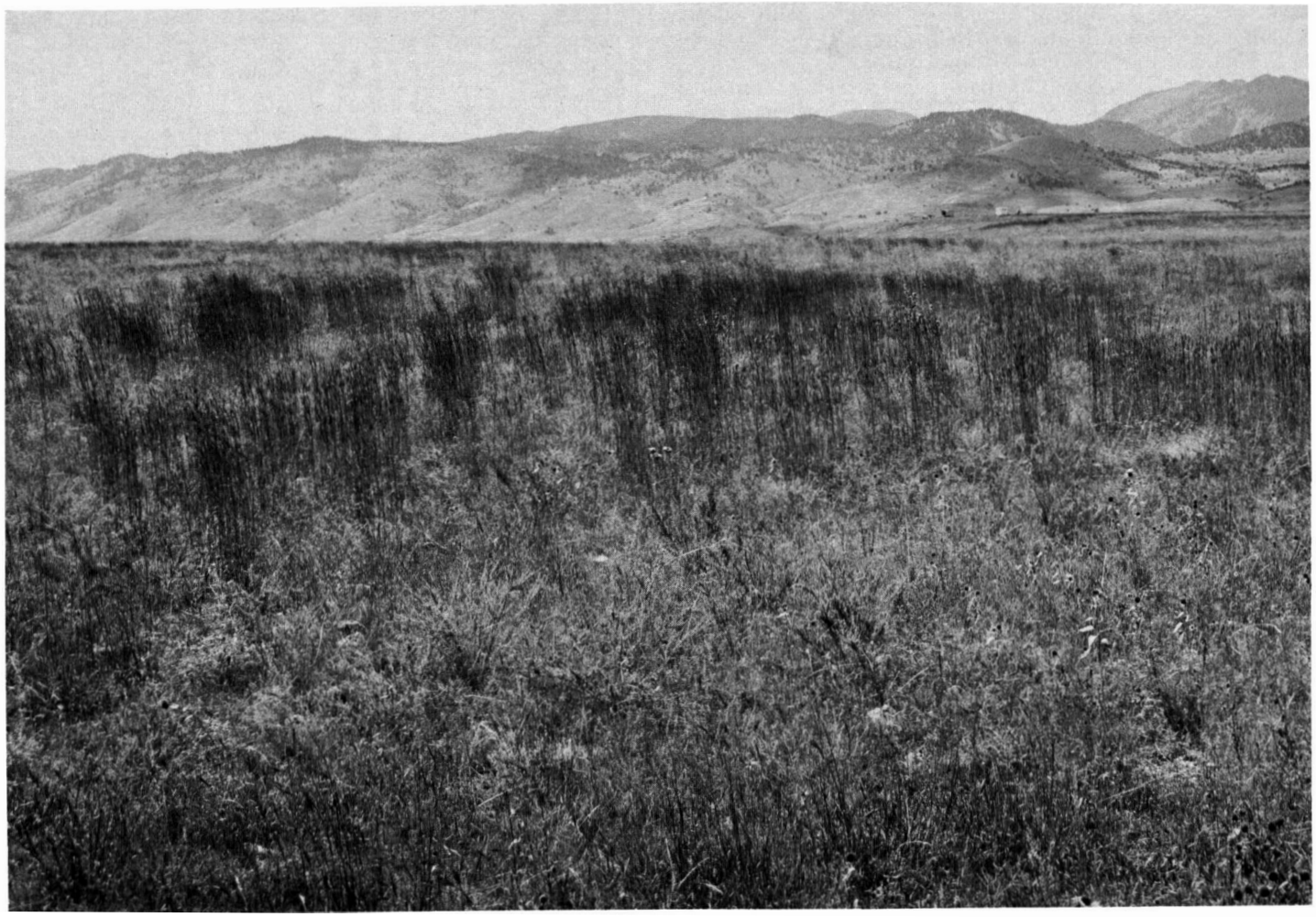

Figure 13.—Native grass in excellent condition on Nederland very cobbly sandy loam, 1 to 12 percent slopes.

Considering the soils the trees grow on, they are best protected from erosion and deterioration when kept ununder tree cover. Trees also enhance the value of these soils for homesites, recreation uses, watershed, and wildlife habitat, and for that reason should be protected.

Management of native woodlands

Ponderosa pine, which makes up the bulk of the forest cover in the survey area, is slow growing. A tree at 10 years of age is ordinarily between 35 and 50 feet in height and 6 to 9.4 inches in diameter. At the present rate of growth, a tree reaches sawlog size (10 inches diameter, breast high) in 160 to 200 years. Stands of timber having such slow growth are considered noncommercial for wood crops. The stands should be given some management, however, so that they will continue to grow and reproduce.

The major management needs are protection from fire, insects, and disease and destructive cutting and grazing. The major insect damage is caused by the Rocky Mountain bark beetle, which kills trees by girdling under the bark. The major disease of ponderosa pine in the Area is dwarf-mistletoe. The mistletoe is a parasitic growth that gradually weakens the tree, slows its growth, and deforms it. Eventually the tree may be killed.

To prevent destructive logging and improve the stand, it is necessary to practice selective cutting. Only trees that interfere with growth of better trees are cut, and trees that are overmature, diseased, or deformed. If posts or poles are cut, they are never taken in a clear-cutting operation. Rather, they are harvested as a part of a thinning that leaves a stand of good trees, well spaced on the ground.

Tree suitability groups

In the Boulder Area, trees and shrubs have been planted both for protection and for beautification for some time. These plantings help protect soils from winds strong enough to damage crops; minimize evaporation of moisture from the soil; help control soil blowing; provide habitat for insect-eating birds and other wildlife; provide protection for streambanks and watersheds; and add to the general beauty of the Area.

East of the foothills, trees ordinarily require more moisture than is provided by natural precipitation, and supplementary water therefore is needed. Irrigation, di-

version of runoff from other areas, summer fallow, and continuous clean cultivation of certain soils are methods of supplementing the supply of moisture.

Soils of the Boulder Area have been placed in tree suitability groups to show their suitability for trees and shrubs. The soils in one group have capacity to produce the same kinds of trees at about the same rate of growth. The mapping units in a tree suitability group can be learned from the "Guide to Mapping Units" at the back of this survey.

TREE SUITABILITY GROUP 1

This group consists of soils of the Fern Cliff and Allens Park series. These are deep to moderately deep, strongly sloping to very steep, moderately coarse textured soils. They contain varying amounts of stone and are slow to warm up in spring. The trees growing in this area are mainly ponderosa pine, Douglas-fir, or lodgepole pine. Planting is seldom, if ever, needed.

TREE SUITABILITY GROUP 2

This group consists of soils suitable for native timber that are now brush covered or that support only scattered trees. These soils are members of the Goldvale, Juget, and Peyton series. They are shallow to moderately deep, strongly sloping to steep, and moderately coarse or coarse textured. They warm slowly in spring. In most areas tree and shrub plantings can survive without supplemental moisture.

The following trees and srubs are among those suitable for planting on soils of this group.

Pinyon pine
Ponderosa pine
Rocky Mountain juniper
Concolor fir
Austrian pine
Colorado blue spruce (in moist areas)
Mountain mahogany
Skunkbush sumac
Chokecherry
Buffaloberry

TREE SUITABILITY GROUP 3

This group consists mainly of deep and moderately deep, nearly level to moderately sloping, well-drained fine sandy loams to silty clay loams. These soils are members of the Colby, Gaynor, Kim, Kutch, Manvel, Nunn, Renohill, Valmont, and Weld series. In most areas supplemental moisture is needed, and it can be obtained by irrigation or by diverting runoff from adjacent areas.

The following are among the trees and shrubs suitable for planting on the soils of this group.

Ponderosa pine
Austrian pine
Rocky Mountain juniper
Concolor fir
Colorado blue spruce
Siberian elm
Green ash
Honeylocust
Hackberry
Caragana
Chokecherry
American plum
Honeysuckle
Lilac
Spirea
Skunkbush sumac
Russan-olive

TREE SUITABILITY GROUP 4

This group consists mainly of deep and moderately deep, nearly level to moderately steep, well-drained sandy loams or loamy sands. These soils are members of the Ascalon, Hargreave, Manter, Otero, and Weld series. Supplemental water is required in most areas.

The following trees and shrubs are among those suitable for the soils of this group.

Ponderosa pine
Austrian pine
Rocky Mountain juniper
Concolor fir
Colorado blue spruce
Siberian elm
Green ash
Honeylocust
Hackberry
Honeysuckle
Sand cherry
Russian-olive
Chokecherry
Lilac
Caragana
American plum

TREE SUITABILITY GROUP 5

This group consists of soils of the Calkins, Loveland, and McClave series. These are nearly level, deep soils that vary in texture. A water table is within the reach of tree roots; it does not fluctuate greatly, and seldom, if ever, reaches the surface. These soils are neither highly alkaline nor highly saline. In some areas, cottonwood trees or willows are already present.

The following trees and shrubs are among those suitable for the soils of this group.

Cottonless cottonwood
Carolina poplar
Golden willow
Weeping willow
White willow
Colorado blue spruce
Russian-olive
Chokecherry
Buffaloberry

TREE SUITABILITY GROUP 6

This group consists of soils of the Baller, Heldt, Gaynor, Laporte, Longmont, Nederland, Niwot, Pinata, Samsil, Shingle, Sixmile and Valmont series; and Colby silty clay loam, wet, 0 to 3 percent slopes; Renohill loam, 3 to 9 percent slopes; Colluvial land; and Terrace escarpments. These soils are not suited to planting. They are shallow to bedrock; strongly sloping; poorly drained or aerated; excessively saline or alkaline, or cobbly, stony, gravelly, sandy, or very clayey.

Recreation [5]

The excellent climate, varied topography, attractive scenery, well-maintained roads, and diversified agriculture of the Boulder Area combine to supply a number of different recreational opportunities. Demand for these opportunities is high and is expected to grow because of the close proximity to the Denver metropolitan area and because of the burgeoning population of the Area. Another asset to the recreation potential is the location of the Area, which is adjacent to both Roosevelt National Forest and Rocky Mountain National Park.

In table 4 the soils of the Boulder Area are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The soils are rated as having *slight*, *moderate*, or *severe* limitations for the specified uses. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these, is required.

[5] By ELDIE W. MUSTARD, biologist, Soil Conservation Service.

TABLE 4.—*Limitations of soils for selected recreational uses*

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
AcA	Ascalon sandy loam, 0 to 1 percent slopes.	Slight	Slight	Slight	Slight.
AcB	Ascalon sandy loam, 1 to 3 percent slopes.	Slight	Slight	Slight to moderate: slope.	Slight.
AcC	Ascalon sandy loam, 3 to 5 percent slopes.	Slight	Slight	Moderate: slope	Slight.
AcD	Ascalon sandy loam, 5 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
AoB	Ascalon-Otero complex, 0 to 3 percent slopes.	Slight	Slight	Slight to moderate: slope.	Slight.
AoC	Ascalon-Otero complex, 3 to 5 percent slopes.	Slight	Slight	Moderate: slope	Slight.
AoD	Ascalon-Otero complex, 5 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
AoE	Ascalon-Otero complex, 9 to 20 percent slopes.	Moderate to severe: slope.	Moderate to severe: slope.	Severe: slope	Slight to moderate: slope.
BaF	Baller stony sandy loam, 9 to 35 percent slopes.	Severe: stony	Moderate to severe: slope.	Severe: slope	Moderate to severe: slope.
CaA	Calkins sandy loam, 0 to 1 percent slopes.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Slight to moderate: somewhat poorly drained.
CaB	Calkins sandy loam, 1 to 3 percent slopes.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Slight to moderate: somewhat poorly drained.
CoB	Colby silty clay loam, 1 to 3 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
CoC	Colby silty clay loam, 3 to 5 percent slopes.	Moderare: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slope	Moderate: silty clay loam surface layer.
CoD	Colby silty clay loam, 5 to 9 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Severe: slope	Moderate: silty clay loam surface layer.
CsB	Colby silty clay loam, wet, 0 to 3 percent slopes.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Ct	Colby-Gaynor association	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Severe: slope	Moderate: silty clay loam surface layer.
Cu	Colluvial land	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: stones, cobbles; subject to runoff.
FcF	Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
GaB	Gaynor silty clay loam, 1 to 3 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
GaD	Gaynor silty clay loam, 3 to 9 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate to severe: slope.	Moderate: silty clay loam surface. layer.
GrF	Goldvale-Rock outcrop complex, 9 to 55 percent slopes.	Severe: rock outcrop.	Moderate to severe: rock outcrop.	Severe: rock outcrop.	Moderate to severe: rock outcrop.
HaB	Hargreave fine sandy loam, 1 to 3 percent slopes.	Slight	Slight	Slight	Slight.
HaD	Hargreave fine sandy loam, 3 to 9 percent slopes.	Slight	Slight	Moderate to severe: slope.	Slight.
HeB	Heldt clay, 0 to 3 percent slopes	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.
HeC	Heldt clay, 3 to 5 percent slopes	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.
JrF	Juget-Rock outcrop complex, 9 to 55 percent slopes.	Severe: rock outcrop.	Moderate to severe: rock outcrop.	Severe: slope	Moderate to severe: slope.
KuD	Kutch clay loam, 3 to 9 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate to severe: slope.	Moderate: clay loam surface layer.
LaE	Laporte very fine sandy loam, 5 to 20 percent slopes.	Moderate to severe: slope.	Moderate to severe: slope.	Severe: bedrock at a depth of less than 20 inches.	Slight to moderate: slope.
LoB	Longmont clay, 0 to 3 percent slopes.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.

TABLE 4.—*Limitations of soils for selected recreational uses*—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lv	Loveland soils	Moderate: clay loam or sandy clay loam surface layer.	Moderate: clay loam or sandy clay loam surface layer.	Moderate: clay loam or sandy clay loam surface layer.	Moderate: clay loam or sandy clay loam surface layer.
Ma	Made land	Severe: old settling basins.	Severe: old settling basins.	Severe: old settling basins.	Severe: old settling basins.
MdA	Manter sandy loam, 0 to 1 percent slopes.	Slight	Slight	Slight	Slight.
MdB	Manter sandy loam, 1 to 3 percent slopes.	Slight	Slight	Slight to moderate: slope.	Slight.
MdD	Manter sandy loam, 3 to 9 percent slopes.	Slight to moderate: slope.	Slight to moderate: slope.	Moderate to severe: slope.	Slight.
Me	Manvel loam	Slight	Slight	Slight to moderate: slope.	Slight.
Mm	McClave clay loam	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
NdD	Nederland very cobbly sandy loam, 1 to 12 percent slopes.	Severe: very cobbly.	Moderate: very cobbly.	Severe: very cobbly.	Moderate to severe: very cobbly.
Nh	Niwot soils	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate to severe: somewhat poorly drained.	Moderate to severe: somewhat poorly drained.
NnA	Nunn sandy clay loam, 0 to 1 percent slopes.	Moderate: sandy clay loam surface layer.	Moderate: sandy clay loam surface layer.	Moderate: slow permeability.	Moderate: sandy clay loam surface layer.
NnB	Nunn sandy clay loam, 1 to 3 percent slopes.	Moderate: sandy clay loam surface layer.	Moderate: sandy clay loam surface layer.	Moderate: slow permeability.	Moderate: sandy clay loam surface layer.
NuA	Nunn clay loam, 0 to 1 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: slow permeability.	Moderate: clay loam surface layer.
NuB	Nunn clay loam, 1 to 3 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: slow permeability.	Moderate: clay clay loam surface layer.
NuC	Nunn clay loam, 3 to 5 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: slow permeability.	Moderate: clay loam surface layer.
NuD	Nunn clay loam, 5 to 9 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Severe: slope	Moderate: clay loam surface layer.
Nv	Nunn-Kim complex	Moderate: clay loam or sandy clay loam surface layer.	Moderate: clay loam or sandy clay loam surface layer.	Moderate: clay loam or sandy clay loam surface	Moderate: clay loam or sandy clay loam surface layer.
PgE	Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes.	Severe: very gravelly.	Moderate: very gravelly.	Severe: slope	Moderate: very gravelly.
PrF	Pinata-Rock outcrop complex, 5 to 55 percent slopes.	Severe: rock outcrop.	Moderate to severe: rock outcrop.	Severe: slope	Moderate to severe: rock outcrop.
ReD	Renohill loam, 3 to 9 percent slopes.	Moderate: slow permeability.	Slight to moderate: slow permeability.	Moderate to severe: slope.	Slight.
RnB	Renohill silty clay loam, 1 to 3 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slow permeability.	Moderate: silty clay loam surface layer.
RnD	Renohill silty clay loam, 3 to 9 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate to severe: slope.	Moderate: silty clay loam surface layer.
Ro	Rock outcrop	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.
SaD	Samsil clay, 3 to 12 percent slopes.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.
SeE	Samsil-Shingle complex, 5 to 25 percent slopes.	Moderate to severe: slope.	Moderate to severe: slope.	Severe: slope	Moderate to severe: clay surface layer in places.
SgE	Shingle-Gaynor complex, 3 to 20 percent slopes.	Moderate to severe: slope.	Moderate to severe: slope.	Moderate to severe: slope.	Slight to moderate: silty clay loam surface layer in places.
SmF	Sixmile stony loam, 10 to 50 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.

TABLE 4.—*Limitations of soils for selected recreational uses*—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
Te	Terrace escarpments	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
VaB	Valmont clay loam, 1 to 3 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
VaC	Valmont clay loam, 3 to 5 percent slopes.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
VcC	Valmont cobbly clay loam, 1 to 5 percent slopes.	Moderate: cobbly clay loam surface layer.	Moderate: cobbly clay loam surface layer.	Severe: cobbly	Moderate: cobbly clay loam surface layer.
VcE	Valmont cobbly clay loam, 5 to 25 percent slopes.	Moderate to severe: slope.	Moderate to severe: slope.	Severe: slope	Moderate: cobbly clay loam surface layer.
WdB	Weld loamy sand, 1 to 4 percent slopes.	Severe: subject to soil blowing.	Moderate: subject to soil blowing.	Moderate to severe: loamy sand.	Moderate: loamy sand.
WeB	Weld fine sandy loam, 1 to 3 percent slopes.	Severe: subject to soil blowing.	Slight	Moderate: slow permeability.	Slight.
WlA	Weld loam, 0 to 1 percent slopes	Moderate: slow permeability.	Slight	Moderate: slow permeability.	Slight.
WlB	Weld loam, 1 to 3 percent slopes	Moderate: slow permeability.	Slight	Moderate: slow permeability.	Slight.
WoB	Weld-Colby complex, 0 to 3 percent slopes.	Moderate: slow permeability.	Slight to moderate: silty clay loam surface layer in places.	Moderate: slow permeability.	Slight to moderate: silty clay loam surface layer in places.
WoC	Weld-Colby complex, 3 to 5 percent slopes.	Moderate: slow permeability.	Slight to moderate: silty clay loam surface layer in places.	Moderate: slow permeability.	Slight to moderate: silty clay loam surface layer in places.

Certain soil qualities and properties of the soils are used in rating the soils. These are mentioned in the following paragraphs.

Camp areas are used intensively for tents and small camp trailers. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. The soils should be suitable for heavy traffic by people, horses, and vehicles. The best soils have mild slopes, good drainage, a surface free of rocks, gravel, and cobbles, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors (fig. 14). These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils have mild slopes, good drainage, a surface free of rocks, gravel, and cobbles, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. In addition, the permeability of the soil is considered.

Playgrounds are used intensively for baseball, football, badminton, and other organized games. Since these areas are subject to intensive foot traffic, they need to possess a soil texture and consistence that gives a firm surface. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to bedrock is also considered.

Paths and trails are used for local and cross-country travel by foot or horseback. It is assumed that the areas will be used as they are naturally. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

In all of the uses of the soils for recreation, the suitability of the soil for growing and maintaining shrubs or other native vegetation that add to the beauty and scenic value have not been considered. These items would be an important consideration in the final evaluation of a site, however. Problems of water supply and sewage are also important factors to consider in the final evaluation of a site, especially for camps, picnic areas, and playgrounds. Information about septic tank absorption fields and buildings can be found in the section "Urban Uses of the Soils."

Some locations exist in some soil areas that are suitable for certain types of recreational uses even though the soil is rated as having severe limitations. An example of this is the area known as the "Flatirons." This is an area of Rock outcrop immediately southwest of the city of Boulder. This area offers good places for climbing, but is rated as having severe limitations for paths and trails because of steep slopes and amount of rock.

Figure 14.—**Picnic area on the Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes.**

Wildlife [6]

Many kinds of wildlife are in the Boulder Area because it has plains, foothills, and mountainous terrain that provide diverse habitat. Activities of man, primarily those associated with farming, have created additional types of habitat. The principle wildlife species in the Area are elk, deer, bear, cottontail rabbit, jackrabbit, dusky grouse, mourning dove, ring-necked pheasant, and various species of waterfowl.

Each kind of wildlife prefers a certain kind of habitat, where it can feed, rest, sleep, breed, and rear young. This habitat, in turn, is dependent on such factors as soil characteristics, topography, vegetation, availability of marshes, and land use.

In the Boulder Area, increasing human population and changes in land use, primarily to accommodate man's needs for farm products, have served to eliminate habitats needed by some kinds of wildlife. Wildlife that could not adapt has disappeared. Deer, elk, antelope, bison, and wild turkeys were once present in large numbers but are now absent or occupy a greatly reduced range. Deer and elk still occupy parts of the Rock outcrop-Juget-Baller association, but bison and antelope do not.

Farming is detrimental to some kinds of wildlife but beneficial to others. The ring-necked pheasant finds habitat in fields farmed for small grain. The farming that creates this habitat also acts to limit numbers of pheasants. Intensive farming, burning of ditchbanks and fence rows, and haying are some practices that hold down the number of pheasants. Waterfowl and mourning doves also use grainfields for food and are measurably benefited.

Irrigation, especially the water reservoirs, aids waterfowl by providing areas where they can rest and from which they can fly to surrounding dryland and irrigated grainfields to eat.

Encroachment by civilization progressively reduces big game hunting opportunities in the Rock outcrop-Juget-Baller association. Establishment of homesites causes irreplaceable habitat losses.

[6] By Eldie W. Mustard, biologist, Soil Conservation Service.

Small game hunting can be increased by improving habitat. This can be done to best advantage where small grains are grown, notably on the Weld-Colby, the Ascalon-Nunn-Manter, and the Nunn-Heldt soil associations. Some of the practices needed are creation of undisturbed permanent nesting areas, improvement of cover by planting windbreaks or similar shelter, and either ceasing or greatly reducing burning along fences and ditches.[7]

Waterfowl hunting can be improved by building dikes in fields where Japanese millet, barley, or a similar grain crop is grown. The field is flooded in the fall with a few inchest of water. Mallards, pintails, teals, and other puddle ducks prefer to take their food under water, and a flooded field of grain therefore is a high-quality area for duck hunting.

Stream fishing for trout is provided through the stocking program of the Colorado Game, Fish, and Parks Department. The most important streams, in the Niwot-Loveland-Calkins soil association, are Boulder Creek and South Boulder Creek, St. Vrain Creek and South St. Vrain Creek, and Left-hand Creek. Some gravel pits, mainly in the Niwot-Loveland-Calkins association, furnish a variety of fishing, including warm water fishing. Irrigation reservoirs, subject to heavy drawdowns, also provide some fishing.

Engineering Uses of the Soils[8]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, shear strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6, which show, respectively, several estimated soil properties significant to engineering; and interpretations for various engineering uses. Additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils," "Formation and Classification of the Soils," and "Urban Uses of the Soils."

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists but are not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering classification systems

The soil scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture. USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Textural classification is primarily for agricultural use, but it is also useful as the initial step for making engineering classifications of soils.

The engineering properties of a soil must be determined or estimated after the textural classifications have been made. The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others, and the AASHO system adopted by the American Association of State Highway Officials.

The Unified system is used to classify soils according to those properties that affect use of the soil as a construction material, such as a dam, or use of the soil as foundation material for a structure, such as a building. In this system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils. The dominantly gravelly soils are identified as GW, GP, GM, and GC, and the dominantly sandy soils are SW, SP, SM, and SC. There are six classes of fine-grained soils. Those soils that have a low liquid limit are identified as ML, CL, and OL, and those that have a high liquid limit are MH, CH, and OH. There is one class of highly organic soils, identified as

[7] See the section "Woodland and Tree Planting" for trees and shrubs suitable for planting.

[8] RONALD I. BLEWITT, conservation engineer and MILLARD F. DILSAVER, area engineer, Soil Conservation Service, assisted in the preparation of this section.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soil for referring to other series that appear in the first column of this table

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Inches	*Feet*	*Inches*			
Allens Park	20–40	(1)	0–17	Gravelly sandy loam	SM	A–2 or A–1
			17–26	Gravelly sandy clay loam	SC	A–4
Mapped only with Fern Cliff soils.			26	Granite.		
*Ascalon: AcA, AcB, AcC, AcD, AoB, AoC, AoD, AoE.	(2)	(1)	0–8	Sandy loam	SM or SC	A–2 or A–4
			8–19	Sandy clay loam	SC or CL	A–6
			19–60	Sandy loam	SC	A–2
For Otero part of AoB, AoC, AoD, and AoE, see Otero series.						
Baller: BaF	10–20	(1)	0–15	Stony sandy loam	SM	A–2 or A–4
			15	Sandstone.		
Calkins: CaA, CaB	(2)	2–4	0–60	Sandy loam	SM or SC	A–4 or A–6
*Colby:						
CoB, CoC, CoD, Ct	(2)	(1)	0–60	Silty clay loam and clay loam	CL	A–6
For Gaynor part of Ct, see Gaynor series.						
CsB	(2)	2–4	0–60	Silty clay loam	CL	A–6
Colluvial land: Cu	(2)	(1)				
Properties too variable to be estimated.						
*Fern Cliff: FcF	(2)	(1)	0–20	Stony sandy loam and loamy sand.	SM	A–2 or A–1
			20–80	Stony sandy loam and sandy clay loam.	SC	A–2 or A–4
For Allens Park part of FcF, see Allens Park series; the properties of the Rock outcrop part of FcF are too variable to be estimated.						
Gaynor: GaB, GaD	20–40	(1)	0–30	Silty clay loam	CL or CH	A–7
			30	Shale.		
Goldvale: GrF	(2)	(1)	0–19	Stony coarse sandy loam	SM	A–1 or A–2
			19–75	Stony sandy clay and stony sandy clay loam.	SC or CL	A–7
The properties of the Rock outcrop part of GrF are too variable to be estimated.						
Hargreave: HaB, HaD	20–40	(1)	0–6	Fine sandy loam	SM or ML	A–4
			6–13	Sandy clay loam	SC	A–6
			13–27	Fine sandy loam	ML or SM	A–4
			27–36	Sandstone.		
Heldt: HeB, HeC	(2)	(1)	0–20	Clay	CH	A–7
			20–60	Clay loam	CL	A–6 or A–7
Juget: JrF	10–20	(1)	0–11	Very gravelly loamy sand	GP or SP	A–1
			11	Granite.		
The properties of the Rock outcrop part of JrF are too variable to be estimated.						
Kim	(2)	(1)	0–60	Clay loam and sandy clay loam.	CL	A–6
Mapped only with Nunn soils.						
Kutch: KuD	20–40	(1)	0–7	Clay loam	CH or CL	A–7
			7–30	Clay	CH	A–7
			30	Shale.		
Laporte: LaE	10–20	(1)	0–13	Very fine sandy loam	SM or ML	A–4
			13	Limestone.		
Longmont: LoB	(2)	1–2	0–60	Clay	CH	A–7

See footnotes at end of table.

significant in engineering

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions
The symbol < means less than. The symbol > means more than]

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
					Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per cm. at 25° C.*	
5–15	85–95	60–80	35–50	20–30	2. 0–6. 0	0. 11–0. 13	6. 1–7. 0	<2. 0	Low.
5–15	85–95	60–80	50–70	35–45	0. 6–2. 0	0. 14–0. 16	6. 1–7. 0	<2. 0	Moderate.
0–5	95–100	95–100	55–70	30–40	2. 0–6. 0	0. 13–0. 15	6. 6–7. 3	<2. 0	Low.
----------	95–100	95–100	75–90	35–55	0. 6–2. 0	0. 14–0. 16	6. 6–7. 8	<2. 0	Moderate.
----------	95–100	95–100	55–70	30–35	2. 0–6. 0	0. 12–0. 14	7. 8–8. 4	<2. 0	Low.
50–70	75–90	70–85	50–70	30–50	6. 0–20. 0	0. 10–0. 13	6. 6–7. 8	<2. 0	Low.
----------	100	90–100	70–90	35–50	2. 0–6. 0	0. 14–0. 16	6. 6–7. 3	2. 0–4. 0	Low.
----------	100	100	90–100	85–95	0. 6–2. 0	0. 19–0. 21	7. 4–8. 4	<2. 0	Moderate.
----------	100	100	90–100	85–95	0. 2–0. 6	0. 19–0. 21	7. 4–9. 0	4. 0–16. 0	Moderate.
10–35	90–100	85–95	40–55	20–30	2. 0–6. 0	0. 11–0. 13	5. 6–6. 5	<2. 0	Low.
10–35	85–95	70–80	40–70	25–50	0. 6–6. 0	0. 11–0. 16	6. 1–6. 5	<2. 0	Low to moderate.
----------	100	100	95–100	85–95	0. 2–0. 6	0. 14–0. 16	7. 9–8. 4	2. 0–4. 0	High.
10–35	90–100	80–95	40–65	15–25	6. 0–20. 0	0. 06–0. 08	5. 6–6. 5	<2. 0	Low.
10–35	90–100	85–95	60–80	35–55	0. 6–2. 0	0. 15–0. 17	5. 6–6. 5	<2. 0	Moderate.
0–10	100	100	70–85	40–55	2. 0–6. 0	0. 13–0. 15	6. 6–7. 3	<2. 0	Low.
----------	100	100	75–90	35–50	0. 6–2. 0	0. 14–0. 16	6. 6–7. 8	<2. 0	Moderate.
----------	100	100	70–85	40–55	2. 0–6. 0	0. 13–0. 15	7. 4–8. 4	<2. 0	Low.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 14–0. 16	7. 4–8. 4	2. 0–4. 0	High.
----------	100	100	90–100	70–85	0. 2–0. 6	0. 15–0. 17	7. 4–8. 4	4. 0–8. 0	Moderate to high.
0–30	45–65	20–35	10–25	0–5	6. 0–20. 0	0. 05–0. 07	6. 1–6. 6	<2. 0	Low.
0–5	100	100	80–100	60–80	0. 6–2. 0	0. 18–0. 20	7. 4–8. 4	2. 0–4. 0	Moderate.
0–5	100	100	90–100	70–80	0. 2–0. 6	0. 19–0. 21	6. 1–7. 3	2. 0–4. 0	High.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 11–0. 13	6. 1–8. 4	4. 0–8. 0	High.
0–5	85–95	75–90	60–80	35–55	0. 6–2. 0	0. 15–0. 17	7. 4–8. 4	<2. 0	Low.
----------	100	90–100	80–100	70–95	0. 06–0. 2	0. 10–0. 13	7. 9–9. 1	8. 0–25. 0	High.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Inches	*Feet*	*Inches*			
Loveland: Lv	(2)	2–4	0–30	Light clay loam	ML or CL	A–6 or A–4
			30–60	Very gravelly sand	GP or GW	A–1
Made land: Ma	(2)	4–5	(3)	(3)	(3)	(3)
Manter: MdA, MdB, MdD	(2)	(1)	0–34	Sandy loam	SC or SM	A–4
			34–60	Loamy sand	SM	A–2
Manvel: Me	(2)	(1)	0–60	Loam	ML	A–4
McClave: Mm	(2)	2–4	0–60	Clay loam and loam	CL or ML	A–6 or A–4
Nederland: NdD	(2)	(1)	0–20	Very cobbly sandy loam or very cobbly sandy clay loam.	GC or SC	A–2 or A–1
			20–60	Very cobbly sandy loam	GM or SM	A–1 or A–2
Niwot: Nh	(2)	0.5–1.5	0–14	Clay loam and loam	CL or ML	A–6 or A–4
			14–60	Gravelly sand	SP	A–1
*Nunn: NnA, NnB, NuA, NuB, NuC, NuD, Nv. For Kim part of Nv, see Kim series.	(2)	(1)	0–10	Clay loam or sandy clay loam	CL or SC	A–6
			10–23	Clay	CH	A–7
			23–60	Clay loam	CL	A–6
Otero Mapped only with Ascalon soils.	(2)	(1)	0–60	Sandy loam	SM	A–2 or A–4
*Peyton: PgE For Juget part of PgE, see Juget series.	(2)	(1)	0–11	Very gravelly loamy sand	SP–SM	A–1
			11–30	Gravelly sandy clay loam	SC	A–2 or A–6
			30–60	Gravelly coarse sandy loam	SM	A–2 or A–1
Pinata: PrF The properties of the Rock outcrop part of PrF are too variable to be estimated.	20–40	(1)	0–12	Very stony loamy fine sand	SM	A–2
			12–32	Very stony clay	CL	A–6
			32	Sandstone.		
Renohill:						
ReD	10–20	(1)	0–16	Clay	CL or CH	A–6 or A–7
			16	Sandstone.		
RnB, RnD	20–40	(1)	0–30	Silty clay loam	CL or CH	A–6 or A–7
			30	Shale.		
Rock outcrop: Ro. Properties too variable to be estimated.						
*Samsil: SaD, SeE For Shingle part of SeE, see Shingle series.	10–20	(1)	0–12	Clay	CL or CH	A–7
			12	Shale.		
*Shingle: SgE For Gaynor part of SgE, see Gaynor series.	10–20	(1)	0–13	Loam	ML	A–4
			13	Shale and sandstone.		
Sixmile: SmF	20–40	(1)	0–4	Stony loam	ML	A–4
			4–30	Clay loam	CL	A–6
			30	Shale.		

See footnotes at end of table.

significant in engineering—Continued

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
					Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per cm. at 25° C.*	
0–10	100	100	85–100	50–80	0. 6–2. 0	0. 19–0. 21	7. 9–8. 4	2. 0–4. 0	Moderate.
10–25	30–50	25–45	15–30	0–5	6. 0–20. 0	0. 03–0. 05	6. 6–7. 8	1. 0–4. 0	Low.
(3)	(3)	(3)	(3)	(3)	(3)	(3)	7. 8–9. 0	1. 0–4. 0	Low.
0–5	80–95	75–95	65–70	40–50	2. 0–6. 0	0. 11–0. 13	6. 6–8. 4	<2. 0	Low.
----------	80–95	75–95	50–75	20–30	6. 0–20. 0	0. 06–0. 08	7. 4–8. 4	2. 0–4. 0	Low.
----------	100	95–100	85–95	60–75	0. 6–2. 0	0. 16–0. 18	7. 8–8. 4	2. 0–4. 0	Low.
0–10	100	95–100	80–95	60–80	0. 6–2. 0	0. 17–0. 20	6. 6–7. 3	2. 0–4. 0	Moderate.
50–65	55–70	45–60	30–40	15–25	0. 6–2. 0	0. 09–0. 13	6. 1–7. 3	<2. 0	Low.
60–75	50–80	40–70	30–50	15–30	2. 0–6. 0	0. 07–0. 09	6. 1–7. 3	<2. 0	Low.
0–10	100	95–100	80–100	55–80	0. 6–2. 0	0. 16–0. 20	6. 6–7. 5	2. 0–4. 0	Moderate.
----------	90–100	60–70	30–40	0–5	>20. 0	0. 04–0. 07	6. 6–7. 5	2. 0–4. 0	Low.
0–10	100	100	85–100	40–75	0. 2–0. 6	0. 17–0. 21	6. 6–7. 8	2. 0–4. 0	Moderate.
----------	100	100	90–100	75–95	0. 06–0. 6	0. 14–0. 16	7. 4–8. 4	2. 0–4. 0	High.
----------	100	100	90–100	70–80	0. 2–0. 6	0. 19–0. 21	7. 4–8. 4	2. 0–4. 0	Moderate.
0–5	100	95–100	55–70	30–40	2. 0–6. 0	0. 11–0. 13	7. 4–8. 4	2. 0–4. 0	Low.
0–10	65–80	25–40	15–25	5–10	6. 0–20. 0	0. 05–0. 06	6. 6–7. 3	<2. 0	Low.
0–10	85–95	60–80	55–70	25–40	0. 6–2. 0	0. 13–0. 15	6. 6–7. 3	<2. 0	Moderate.
0–10	85–95	60–80	40–55	15–25	2. 0–6. 0	0. 10–0. 13	6. 6–7. 3	<2. 0	Low.
50–90	85–95	80–90	50–70	15–30	6. 0–20. 0	0. 09–0. 10	6. 1–6. 5	<2. 0	Low.
50–90	85–95	80–90	72–90	60–85	0. 06–0. 2	0. 14–0. 16	6. 1–7. 0	<2. 0	Moderate.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 14–0. 16	6. 6–7. 8	2. 0–4. 0	High.
----------	100	100	95–100	85–95	0. 06–0. 2	0. 19–0. 21	7. 4–8. 4	2. 0–4. 0	High.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 14–0. 16	7. 4–8. 4	2. 0–8. 0	High.
----------	100	100	85–95	60–75	0. 6–2. 0	0. 16–0. 18	7. 4–8. 4	4. 0–8. 0	Low.
15–25	100	100	85–95	60–75	0. 6–2. 0	0. 16–0. 18	7. 4–8. 4	2. 0–4. 0	Moderate.
----------	100	100	90–100	70–80	0. 6–2. 0	0. 19–0. 21	7. 4–8. 4	4. 0–8. 0	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Inches	*Feet*	*Inches*			
Terrace escarpments: Te. Properties too variable to be estimated.						
Valmont:						
VaB, VaC	(2)	(1)	0–7	Clay loam	CL	A–6
			7–24	Clay	CH	A–7
			24–60	Very gravelly loam	GM	A–1
VcC, VcE	(2)	(1)	0–8	Cobbly clay loam	CL	A–6
			8–22	Cobbly clay	CH	A–7
			22–60	Very gravelly loam	GM	A–1
*Weld:						
WdB, WeB	(2)	(1)	0–12	Loamy sand and fine sandy loam.	SM	A–2 or A–4
			12–36	Clay loam	CL or CH	A–6 or A–7
			36–60	Loam	ML	A–4
WlA, WlB, WoB, WoC	(2)	(1)	0–6	Loam	ML	A–4
For Colby part of WoB and WoC, see Colby series.			6–12	Clay	CL or CH	A–6 or A–7
			12–60	Loam	ML	A–4

[1] No water table or evidence of a water table was encountered to a depth of 5 feet or to the depth the soil was studied.
[2] Bedrock was not encountered within a depth of 60 inches or to the depth the soil was studied.

TABLE 6.—*Engineering interpretations*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in for referring to other series that

Soil series and map symbols	Suitability of soils as a source of—		
	Road fill	Sand and gravel	Topsoil
Allens Park	Poor: limited material	Unsuitable: limited material.	Poor: coarse fragments
Mapped only with Fern Cliff soils.			
*Ascalon:			
AcA, AcB, AoB	Fair to good: low to moderate shrink-swell potential.	Unsuitable to poor: excessive fines.	Good to fair: limited material.
For Otero part of AoB, see Otero series.			
AcC, AcD, AoC, AoD, AoE	Fair to good: low to moderate shrink-swell potential.	Unsuitable to poor: excessive fines.	Good to fair: limited material.
For Otero part of AoC, AoD, and AoE, see Otero series.			
Baller: BaF	Poor: bedrock at depth of 10 to 20 inches.	Unsuitable: bedrock at depth of 10 to 20 inches.	Poor: stones; bedrock at depth of 10 to 20 inches.
Calkins: CaA, CaB	Fair: high water table at depth of 2 to 4 feet; low shrink-swell potential.	Poor: excessive fines	Fair: high water table

significant in engineering—Continued

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
					Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per cm. at 25° C.*	
0–15	80–95	75–95	65–80	50–65	0. 6–2. 0	0. 17–0. 20	6. 6–7. 8	<2. 0	Moderate.
5–15	85–95	65–95	60–85	50–80	0. 2–0. 6	0. 14–0. 16	6. 6–8. 4	<2. 0	High.
10–20	35–50	25–35	20–30	10–20	2. 0–6. 0	0. 07–0. 09	7. 4–8. 4	4. 0–8. 0	Low.
35–50	70–85	70–80	60–70	40–55	0. 6–2. 0	0. 13–0. 16	6. 6–7. 3	<2. 0	Low.
25–40	70–85	70–80	65–75	50–65	0. 2–0. 6	0. 10–0. 13	6. 6–8. 4	<2. 0	Moderate.
10–25	35–50	25–35	20–30	10–20	2. 0–6. 0	0. 07–0. 09	7. 4–8. 4	4. 0–8. 0	Low.
----------	100	100	75–95	25–45	2. 0–6. 0	0. 10–0. 15	6. 6–7. 3	<2. 0	Low.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 14–0. 16	6. 6–7. 3	<2. 0	High.
----------	100	100	85–100	60–80	0. 2–2. 0	0. 16–0. 20	7. 4–8. 4	2. 0–4. 0	Moderate.
----------	100	100	85–95	60–75	0. 6–2. 0	0. 16–0. 18	6. 6–7. 3	<2. 0	Moderate.
----------	100	100	90–100	75–95	0. 06–0. 2	0. 14–0. 16	6. 6–7. 3	<2. 0	High.
----------	100	100	85–95	60–75	0. 6–2. 0	0. 16–0. 18	7. 4–8. 4	2. 0–4. 0	Moderate.

[3] Materials consisting of waste from sugar beet processing plant. These materials are too variable to estimate.

of soil properties

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

Soil features affecting—				
Pond reservoir areas	Embankments and dikes	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Bedrock at depth of 20 to 40 inches; 15 to 60 percent slopes.	Medium permeability; fair compaction; medium piping potential.	Drainage not needed-----	15 to 60 percent slopes---	Bedrock at depth of 20 to 40 inches; 15 to 60 percent slopes.
Moderate permeability; 0 to 3 percent slopes.	Medium to low permeability; fair to good compaction; medium piping potential.	Moderate permeability---	Rapid intake rate; high available water capacity; 0 to 3 percent slopes.	Sandy loam surface layer; deep; 0 to 3 percent slopes.
Moderate permeability; 3 to 20 percent slopes.	Medium to low permeability; fair to good compaction; medium piping potential.	Moderate permeability---	Rapid intake rate; high available water capacity; 3 to 20 percent slopes.	Sandy loam surface layer; deep; 3 to 20 percent slopes.
Bedrock at depth of 10 to 20 inches; 9 to 35 percent slopes.	Stony surface layer; bedrock at depth of 10 to 20 inches.	Drainage not needed-----	Stony; shallow; 9 to 35 percent slopes.	Stony; bedrock at depth of 10 to 20 inches; 9 to 35 percent slopes.
High water table; moderately rapid permeability.	Medium permeability; fair to good compaction; medium to high piping potential.	High water table; moderately rapid permeability.	Rapid intake rate; high available water capacity.	Sandy loam surface layer; water table at depth of 2 to 4 feet; 0 to 3 percent slopes.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability of soils as a source of—		
	Road fill	Sand and gravel	Topsoil
*Colby: CoB	Fair: moderate shrink-swell potential.	Unsuitable	Fair: silty clay loam texture; limy.
CoC, CoD, Ct For Gaynor part of Ct, see Gaynor series, mapping unit GaD.	Fair: moderate shrink-swell potential.	Unsuitable	Fair: silty clay loam texture; limy.
CsB	Fair: moderate shrink-swell potential; water table at depth of 2 to 4 feet.	Unsuitable	Poor: clayey texture; high water table.
Colluvial land: Cu. Properties too variable to be estimated.			
*Fern Cliff: FcF For Allens Park and Rock outcrop parts of FcF, see Allens Park series and Rock outcrop respectively.	Fair to poor: stones; 15 to 60 percent slopes.	Poor: excessive fines	Poor: stones; steep slopes.
Gaynor: GaB	Poor: limited material; high shrink-swell potential.	Unsuitable	Fair: silty clay loam; limy.
GaD	Poor: limited material; high shrink-swell potential.	Unsuitable	Fair: silty clay loam; limy.
Goldvale: GrF	Poor to fair: stones; 9 to 55 percent slopes; moderate shrink-swell potential.	Unsuitable	Poor: stones; sandy textured surface layer.
Hargreave: HaB	Fair: limited material; low to moderate shrink-swell potential.	Unsuitable	Fair: limited material
HaD	Fair: limited material; low to moderate shrink-swell potential.	Unsuitable	Fair: limited material
Heldt: HeB	Poor: high shrink-swell potential.	Unsuitable	Poor: clay texture
HeC	Poor: high shrink-swell potential.	Unsuitable	Poor: clay texture
*Juget: JrF For the Rock outcrop part of JrF, see Rock outcrop.	Poor: bedrock at depth of 10 to 20 inches; limited material.	Unsuitable: bedrock at a depth of 10 to 20 inches.	Poor: very gravelly

of soil properties—Continued

Soil features affecting—				
Pond reservoir areas	Embankments and dikes	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Moderate permeability; 1 to 3 percent slopes.	Medium to low shear strength; medium compressibility.	Moderate permeability; unstable ditchbanks.	Moderate intake rate; high available water capacity.	Unstable material; moderate shrink-swell potential.
Moderate permeability; 3 to 9 percent slopes.	Medium to low shear strength; medium compressibility.	Moderate permeability; unstable ditchbanks; 3 to 9 percent slopes.	Moderate intake rate; high available water capacity; 3 to 9 percent slopes.	Unstable material; moderate shrink-swell potential; 3 to 9 percent slopes.
Water table at depth of 2 to 4 feet; 0 to 3 percent slopes.	Medium to low shear strength; medium compressibility.	Water table at depth of 2 to 4 feet; moderate permeability; unstable ditchbanks.	Water table at depth of 2 to 4 feet.	Water table at depth of 2 to 4 feet; unstable material; moderate shrink-swell potential.
Moderate to moderately rapid permeability; steep slopes.	Stones; fair compaction; medium piping potential.	Drainage not needed-----	15 to 60 percent slopes---	Erosion hazard; 16 to 60 percent slopes.
Bedrock at depth of 20 to 40 inches; moderately slow permeability; 1 to 3 percent slopes.	Medium to low shear strength; medium to low compaction.	Bedrock at depth of 20 to 40 inches.	Moderate intake rate; moderate available water capacity; 1 to 3 percent slopes.	Unstable material; bedrock at depth of 20 to 40 inches; 1 to 3 percent slopes.
Bedrock at depth of 20 to 40 inches; moderately slow permeability; 3 to 20 percent slopes.	Medium to low shear strength; medium to low compaction.	Bedrock at depth of 20 to 40 inches; 3 to 20 percent slopes.	Moderate intake rate; medium available water capacity; slope.	Unstable material; bedrock at depth of 20 to 40 inches; 3 to 20 percent slopes.
Stones; moderate permeability; 9 to 55 percent slopes.	Fair to good stability; fair to good compaction; medium piping potential.	Drainage not needed-----	9 to 55 percent slopes----	Stones; 9 to 55 percent slopes.
Bedrock at depth of 20 to 40 inches; moderate permeability; 1 to 3 percent slopes.	Medium permeability; fair shear strength; fair compaction; high piping potential.	Bedrock at depth of 20 to 40 inches; 1 to 3 percent slopes.	Moderate intake rate; high available water capacity.	Bedrock at depth of 20 to 40 inches; 1 to 3 percent slopes.
Bedrock at depth of 20 to 40 inches; moderately rapid permeability; 3 to 9 percent slopes.	Medium permeability; fair shear strength; fair compaction; high piping potential.	Bedrock at depth of 20 to 40 inches; 3 to 9 percent slopes.	Moderate intake rate; high available water capacity; 3 to 9 percent slopes.	Bedrock at depth of 20 to 40 inches; 3 to 9 percent slopes.
Slow permeability; 0 to 3 percent slopes.	Low shear strength; poor compaction; high shrink-swell potential.	Slow permeability-------	Slow intake rate; high available water capacity; 0 to 3 percent slopes.	Clay soils; fair to poor stability; 0 to 3 percent slopes.
Slow permeability; 3 to 5 percent slopes.	Low shear strength; poor compaction; high shrink-swell potential.	Slow permeability-------	Slow intake rate; high available water capacity; 3 to 5 percent slopes.	Clay soils; fair to poor stability; 3 to 5 percent slopes.
Bedrock at depth of 10 to 20 inches; 9 to 55 percent slopes.	Very gravelly material; bedrock at depth of 10 to 20 inches; rapid permeability.	Drainage not needed-----	9 to 55 percent slopes----	Bedrock at depth of 10 to 20 inches; 9 to 55 percent slopes.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability of soils as a source of—		
	Road fill	Sand and gravel	Topsoil
Kim Mapped only with Nunn soils.	Fair: moderate shrink-swell potential.	Unsuitable	Fair: clay loam; limy
Kutch: KuD	Poor: limited material; high shrink-swell potential.	Unsuitable	Poor: clay texture
Laporte: LaE	Poor: bedrock at depth of 0 to 20 inches.	Unsuitable	Poor: bedrock at depth of 10 to 20 inches.
Longmont: LoB	Poor: high water table; high shrink-swell potential.	Unsuitable	Poor: clay; high salt content; high water table.
Loveland: Lv	Fair: moderate shrink-swell potential.	Good for gravel below depth of 3 feet; good for sand after sieving.	Fair: clay loam texture
Made land: Ma. Properties too variable to be estimated.			
Manter: MdA, MdB	Good	Poor for sand; excessive fines.	Good
MdD	Good	Poor for sand; excessive fines.	Good
Manvel: Me	Fair: ML material with low plasticity.	Unsuitable	Fair: high lime content
McClave: Mm	Fair: moderate shrink-swell potential.	Unsuitable	Fair: clay loam texture
Nederland: NdD	Good to fair: very cobbly.	Unsuitable: but may be suitable for crushed rock.	Poor: very cobbly material.
Niwot: Nh	Fair: water table at depth of ½ to 1½ feet.	Good for sand; water table at depth of ½ to 1½ feet.	Fair: limited material; clay loam texture.
*Nunn: NnA, NnB, NuA, NuB, Nv For Kim part of Nv, see Kim series.	Poor: high shrink-swell potential.	Unsuitable	Fair: clay loam texture; limited material.
NuC, NuD	Poor: high shrink-swell potential.	Unsuitable	Fair: clay loam texture; limited material.

of soil properties—Continued

Soil features affecting—				
Pond reservoir areas	Embankments and dikes	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Moderate permeability; 0 to 3 percent slopes.	Fair to medium shear strength; fair to medium compaction.	Moderate permeability	Moderate intake rate; high available water capacity.	Deep loamy soil; 0 to 3 percent slopes.
Bedrock at depth of 20 to 40 inches; slow permeability; 3 to 9 percent slopes.	Low shear strength; poor compaction.	Drainage not needed	Slow intake rate; 3 to 9 percent slopes.	Bedrock at depth of 20 to 40 inches; poor stability; 3 to 9 percent slopes.
Bedrock at depth of 10 to 20 inches; 5 to 20 percent slopes.	Bedrock at depth of 10 to 20 inches.	Drainage not needed	Slopes of 5 to 20 percent	Bedrock at depth of 10 to 20 inches; 5 to 20 percent slopes.
High water table; slow permeability; 0 to 3 percent slopes.	Low shear strength; poor compaction.	High salt and sodium content; slow permeability.	High sodium content; high water table; slow intake rate.	Clay soil; high water table; 0 to 3 percent slopes.
High water table; rapid permeability below depth of 3 feet; 0 to 1 percent slopes.	High compacted permeability below depth of 3 feet; medium to low shear strength; fair compaction in the upper 3 feet.	Rapid permeability below depth of 3 feet; some outlet problems.	Moderate intake rate; moderate available water capacity.	Moderately deep clay loam soil overlying gravelly substratum; high water table; 0 to 1 percent slopes.
Rapid permeability below depth of 3 feet; 0 to 3 percent slopes.	Medium compacted permeability; medium shear strength; fair compaction; high to medium piping potential.	Moderately rapid permeability.	Rapid intake rate; moderate available water capacity; 0 to 3 percent slopes.	Deep soil; sandy loam surface layer and subsoil; 0 to 3 percent slopes.
Rapid permeability below depth of 3 feet; 3 to 9 percent slopes.	Medium compacted permeability; medium shear strength; fair compaction; high to medium piping potential.	Moderately rapid permeability.	Rapid intake rate; moderate available water capacity; 3 to 9 percent slopes.	Deep soil; sandy loam surface layer and subsoil; 3 to 9 percent slopes.
Moderate permeability; moderate seepage.	Low shear strength; poor compaction; high piping potential.	Moderate permeability; poor bank stability.	Moderate intake rate; high available water capacity.	Deep soil; poor stability; erosion hazard; 1 to 3 percent slopes.
Water table at depth of 2 to 4 feet; moderate permeability.	Medium to low permeability; medium to low shear strength; poor to fair compaction; medium to high piping potential.	Water table at depth of 2 to 4 feet; moderate permeability.	Water table at depth of 2 to 4 feet; moderate intake rate; high available water capacity.	Deep soil; water table at depth of 2 to 4 feet.
Very cobbly; moderate permeability; 1 to 12 percent slopes.	Medium to low permeability; medium shear strength; fair to good compaction.	Drainage not needed	Very cobbly; 1 to 12 percent slopes.	High content of cobbles and stones; fair to good stability; 1 to 12 percent slopes.
Water table at depth of ½ to 1½ feet; rapid permeability below the surface layer.	High permeability; medium shear strength; good compaction.	Water table at depth of ½ to 1½ feet; outlet problems; subject to flooding.	Water table at depth of ½ to 1½ feet; low available water capacity; subject to flooding.	Shallow loamy soil overlying gravelly sand substratum; flooding in places.
Slow permeability; 0 to 3 percent slopes.	Slow permeability; poor to fair stability; poor to fair compaction.	Slow to moderate permeability; poor to fair bank stability.	Slow to moderate intake rate; high available water capacity.	Deep soil; clay subsoil; 0 to 3 percent slopes.
Slow permeability; 3 to 9 percent slopes.	Slow permeability; poor to fair stability; poor to fair compaction.	Slow to moderate permeability; poor to fair bank stability.	Slow intake rate; high available water capacity; 3 to 9 percent slopes.	Deep soil; clay subsoil; 3 to 9 percent slopes.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability of soils as a source of—		
	Road fill	Sand and gravel	Topsoil
Otero: Mapped only with Ascalon soils. Otero part of AoB	Good	Poor for sand; excessive fines.	Fair: high lime content
Otero part of AoC, AoD, AoE	Good	Poor for sand; excessive fines.	Fair: high lime content
*Peyton: PgE For Juget part of PgE, see Juget series.	Fiar to good: low to moderate shrink-swell potential.	Poor for sand; excessive fines.	Poor: very gravelly loamy sand surface layer.
Pinata: PrF	Poor: high content of stones; moderate shrink-swell potential.	Unsuitable	Poor: very stony loamy fine sand surface layer.
Renohill: ReD	Poor: bedrock at depth of 10 to 20 inches; high shrink-swell potential.	Unsuitable	Poor: bedrock at depth of 10 to 20 inches.
RnB	Poor: limited material; high shrink-swell potential.	Unsuitable	Fair: silty clay loam texture; limited material.
RnD	Poor: limited material; high shrink-swell potential.	Unsuitable	Fair: silty clay loam texture; limited material.
Rock outcrop: Ro. Severe limitations for most uses.			
*Samsil: SaD, SeE For Shingle part of SeE, see Shingle series.	Poor: bedrock at depth of 10 to 20 inches; high shrink-swell potential.	Unsuitable	Poor: clay texture; bedrock at depth of 10 to 20 inches.
*Shingle: SgE For Gaynor part of SgE, see Gaynor series, mapping unit GaD.	Poor: bedrock at depth of 10 to 20 inches.	Unsuitable	Poor: bedrock at depth of 10 to 20 inches.
Sixmile: SmF	Fair: stones and boulders; moderate shrink-swell potential.	Unsuitable	Poor: stones and boulders.
Terrace escarpments: Te. Severe limitations for most uses.			

of soil properties—Continued

Soil features affecting—				
Pond reservoir areas	Embankments and dikes	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Moderately rapid permeability; 0 to 3 percent slopes.	Medium permeability; medium shear strength; fair to good compaction; moderate piping potential.	Moderately rapid permeability.	Rapid intake rate; moderate available water capacity; 0 to 3 percent slopes.	Deep sandy loam; 0 to 3 percent slopes.
Moderately rapid permeability; 3 to 20 percent slopes.	Medium permeability; medium shear strength; fair to good compaction; moderate piping potential.	Moderately rapid permeability.	Rapid intake rate; low available water capacity; 3 to 20 percent slopes.	Deep sandy loam; 3 to 20 percent slopes.
Moderate to moderately rapid permeability; 5 to 20 percent slopes.	Medium permeability; medium to low shear strength; fair to good compaction; low to medium piping potential.	Drainage not needed-----	Slopes of 5 to 20 percent-	Very gravelly loamy sand surface layer; 5 to 20 percent slopes.
High content of stones; 5 to 55 percent slopes.	High content of stones; limited material.	Drainage not needed-----	5 to 55 percent slopes----	Very stony loamy sand surface layer; 5 to 55 percent slopes.
Bedrock at depth of 10 to 20 inches; slow permeability; 3 to 9 percent slopes.	Bedrock at depth of 10 to 20 inches; fair to poor compaction.	Drainage not needed-----	Bedrock at depth of 10 to 20 inches; 3 to 9 percent slopes.	Bedrock at depth of 10 to 20 inches; 3 to 9 percent slopes.
Bedrock at depth of 20 to 40 inches; 1 to 3 percent slopes.	Slow permeability; medium to low shear strength; fair compaction.	Bedrock at depth of 20 to 40 inches; slow permeability.	Slow intake rate; moderate available water capacity; 1 to 3 percent slopes.	Bedrock at depth of 20 to 40 inches; fair stability; 1 to 3 percent slopes.
Bedrock at depth of 20 to 40 inches; slow permeability; 3 to 9 percent slopes.	Slow permeability; medium to low shear strength; fair compaction.	Bedrock at depth of 20 to 40 inches; slow permeability.	Slow intake rate; moderate available water capacity; 3 to 9 percent slopes.	Bedrock at depth of 20 to 40 inches; fair stability; 3 to 9 percent slopes.
Bedrock at depth of 10 to 20 inches; slow permeability; 3 to 25 percent slopes.	Bedrock at depth of 10 to 20 inches; fair compaction.	Drainage not needed-----	Bedrock at depth of 10 to 20 inches; low available water capacity; 3 to 25 percent slopes.	Bedrock at depth of 10 to 20 inches; 3 to 25 percent slopes.
Bedrock at depth of 10 to 20 inches; moderate permeability; 3 to 25 percent slopes.	Bedrock at depth of 10 to 20 inches; high piping potential.	Drainage not needed-----	Bedrock at depth of 10 to 20 inches; moderate intake rate; low available water capacity; 3 to 25 percent slopes.	Bedrock at depth of 10 to 20 inches; 3 to 25 percent slopes.
Bedrock at depth of 20 to 40 inches.	Stones and boulders; fair compaction; low to medium piping potential.	Drainage not needed-----	Slopes of 10 to 50 percent.	Stones and boulders; 10 to 50 percent slopes.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability of soils as a source of—		
	Road fill	Sand and gravel	Topsoil
Valmont: VaB	Poor: high shrink-swell potential in subsoil.	Poor: gravel below depth of 2 feet; unsuited for sand.	Poor: clay loam texture; limited material.
VaC	Poor: high shrink-swell potential in subsoil.	Poor: gravel below depth of 2 feet; unsuited for sand.	Poor: clay loam texture; limited material.
VcC. VcE	Poor: high shrink-swell potential in subsoil.	Poor: gravel below depth of 2 feet; unsuited for sand.	Sandy and cobbly
*Weld: WdB	Poor: high shrink-swell potential in subsoil.	Unsuitable	Poor: loamy sand surface layer.
WeB. WlA. WlB. WoB For Colby part of WoB, see Colby series, mapping unit CoB.	Poor: high shrink-swell potential in subsoil.	Unsuitable	Fair: loamy surface layer; limited material.
WoC For Colby part of WoC, see Colby series, mapping unit CoC.	Poor: high shrink-swell potential in subsoil.	Unsuitable	Fair: loamy surface layer; limited material.

of soil properties—Continued

Soil features affecting—				
Pond reservoir areas	Embankments and dikes	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Moderately slow permeability; 1 to 3 percent slopes.	Fair compaction and medium shear strength above depth of 2 feet; good compaction and high shear strength below depth of 2 feet.	Moderately slow permeability; fair bank stability.	Moderate intake rate; moderate available water capacity; 1 to 3 percent slopes.	1 to 3 percent slopes.
Moderate permeability; 3 to 5 percent slopes.	Fair compaction and medium shear strength above depth of 2 feet; good compaction and high shear strength below depth of 2 feet.	Moderately slow permeability; fair bank stability.	Moderate intake rate; moderate available water capacity; 3 to 5 percent slopes.	3 to 5 percent slopes
Moderately slow permeability; 1 to 25 percent slopes.	Fair compaction and medium shear strength above depth of 2 feet; good compaction and high shear strength below depth of 2 feet.	Moderately slow permeability; fair bank stability.	Cobbly surface layer; moderate intake rate; moderate available water capacity; 1 to 25 percent slopes.	Cobbly surface layer; 1 to 25 percent slopes.
Slow permeability; 1 to 4 percent slopes.	Slow permeability; fair compaction; high piping potential.	Slow permeability; fair bank stability.	Rapid to moderate intake rate; high available water capacity; 1 to 4 percent slopes.	Loamy sand surface layer; high erosion hazard; 1 to 4 percent slopes.
Slow permeability; low seepage rate; 0 to 3 percent slopes.	Slow permeability; fair compaction; high piping potential.	Slow permeability; fair bank stability.	Moderate to slow intake rate; high available water capacity; 0 to 3 percent slopes.	Loamy sand surface layer; high erosion hazard; 0 to 3 percent slopes.
Slow permeability; low seepage rate; 3 to 5 percent slopes.	Slow permeability; fair compaction; high piping potential.	Slow permeability; fair bank stability.	Moderate to slow intake rate; high available water capacity; 3 to 5 percent slopes.	Loamy sand surface layer; high erosion hazard; 3 to 5 percent slopes.

Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Within fairly broad limits, all soil materials are classified numerically between these two extremes, according to their load-carrying ability. Three of the seven basic groups may be further divided into subgroups to designate variations within a group. Also within each group, the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. Group indexes range from 0 for the best subgrade material to 20 for the poorest. Increasing values of group indexes denote decreasing load-carrying capacity. The estimated AASHO classification is given in table 5 for all soils mapped in the survey area. No soil samples were collected in this area for laboratory analyses.

Soil properties significant to engineering

Several estimates of soil properties significant in engineering are given in table 5. These estimates are made by layers of the soil having significantly different properties. The estimates are based on test data for these and similar soils, and on experience with the same kinds of soil in other survey areas. Following are explanations of some of the column in table 5.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms are based on the production of the different sized mineral particles. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary at back of the survey.

Percentage passing sieve shows the percentage of soil material that is smaller in diameter than the openings in the given screen.

Permeability indicates the rate at which water moves through undisturbed soil material. The estimates are based largely on texture, structure, and porosity, but they do not take into account such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction is a measure of the acidity or alkalinity of a soil, expressed in pH values. The soil pH indicates the corrosiveness of a soil and the protection needed for structures, such as pipelines, when they are placed in the soil.

Salinity refers to the amount of soluble salt in the soil that is more soluble than gypsum. It is expressed as the electrical conductivity of a saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when its gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are potentially the most hazardous.

Engineering interpretations

In table 6 of the soils of the Boulder Area are rated according to their suitability as a source of road fill, sand and gravel, and topsoil. Other columns in table 6 name the soil features that affect the location of pond reservoir areas, embankments and dikes, drainage of cropland and pasture, irrigation, and terraces and diversions. The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data soils in survey areas nearby or adjoining, and on the experience of engineers and soil scientists of the Boulder Area.

Soil suitability is rated by the terms *good*, *fair*, and *poor*. *Good* means soil properties generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Fair* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. Poor means soil properties so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer

is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping of favorable stability, shrink-swell potential, shear strength, and compactability. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion or soil blowing; soil texture; content of stones; accumulations of salts and alkali; deth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Urban Uses of the Soils

Urbanization in the Boulder Area has been increasing in the past few years. This increase is due to the nearness of the Area to the Denver metropolitan area; to the establishment of various industrial and governmental installations in or near the Area; and to the establishment of a large academic community created by the University of Colorado at Boulder. This availability of employment opportunities partly accounts for the increase in population. Good roads, a broad spectrum of cultural and outdoor recreation facilities, the favorable climate, and the mountains surrounding also contribute toward making the Boulder Area a desirable place to live.

This section is meant to point out the differences and limitations for urban use of soils. These interpretations are generalized and should be used primarily in planning more detailed investigations that determine the characteristics of the soil material in place at the proposed site.

Limitations of the soils for urban uses

In table 7 the soils of the Boulder Area are rated according to their limitation for septic tank absorption fields, sewage lagoons, shallow excavations, dwellings without basements, local roads and streets, and sanitary landfill. The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 5, on test data for soils in survey areas nearby or adjoining, and on the experience of engineers and soil scientists of the Boulder Area.

Soil limitations are indicated by the ratings *slight*, *moderate*, and *severe*. *Slight* means soil properties generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable, but can be overcome or modified by special planning and design. *Severe* means soil properties so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance. Unless otherwise stated the ratings in table 7 apply only to a depth of about 5 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be deeper. Following are explanations of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor. These are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock becomes important.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and ceme teries. Desirable soil proporties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 7, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all

TABLE 7.—*Limitations of the soils for urban uses*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfill [1]
Allens Park Mapped only with Fern Cliff soils.	Severe: slope	Severe: slope	Severe: bedrock at depth of 20 to 40 inches.	Severe: slope	Severe: slope	Severe: bedrock at depth of 20 to 40 inches; slope.
*Ascalon: AcA, AcB, AcC, AoB, AoC. For Otero parts of AoB and AoC, see Otero series.	Slight	Moderate: moderate permeability; slopes.	Slight	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Slight.
AcD, AoD. For Otero part of AoD, see Otero series.	Slight	Moderate where slope is 2 to 7 percent; severe where slope is more than 7 percent.	Slight	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Slight.
AoE. For Otero part of AoE, see Otero series.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Severe: slope	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Moderate to severe: slope.	Slight where slope is less than 15 percent; moderate where slope is 15 to 20 percent.
Baller: BaF	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches; slope.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches; slope.	Severe: stones; slope.	Severe: bedrock at depth of less than 20 inches.
Calkins: CaA, CaB	Severe: water table at depth of 2 to 3 feet.	Severe: water table at depth of 2 to 3 feet.	Moderate to severe: water table at depth of 2 to 3 feet.	Moderate: water table at depth of 2 to 3 feet.	Moderate: water table at depth of 2 to 3 feet.	Severe: water table at depth of 2 to 3 feet.
*Colby: CoB, CoC	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam texture.
CoD	Moderate: moderate permeability; slope.	Moderate where slope is 2 to 7 percent; severe where slope is more than 7 percent.	Slight	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam texture.
CsB	Severe: water table at depth of 2 to 4 feet.	Severe: water table at depth of 2 to 4 feet.	Severe: water table at depth of 2 to 4 feet.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: water table at depth of 2 to 4 feet.

See footnote at end of table.

TABLE 7.—*Limitations of the soils for urban uses*—Continued

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfill [1]
*Colby—Continued Ct—For Gaynor part of Ct, see Gaynor series.	Moderate: moderate permeability; slope.	Severe: slope.	Slight.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam texture.
Colluvial land: Cu. Materials too variable to be estimated.						
*Fern Cliff: FcF—For Allens Park and Rock outcrop parts of FcF, see Allens Park series and Rock outcrop, respectively.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: rock outcrop; stones; slope.
Gaynor: GaB, GaD	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: soft shale at depth of 20 to 40 inches.
*Goldvale: GrF—For Rock outcrop part of GrF, see Rock outcrop.	Severe: rock outcrop.	Severe: rock outcrop; slope.	Severe: rock outcrop.	Severe: rock outcrop.	Severe: rock outcrop; slope.	Severe: rock outcrop; slope.
Hargreave: HaB, HaD	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Heldt: HeB, HeC	Severe: slow permeability.	Slight where slope is 0 to 3 percent; moderate where slope is 3 to 5 percent.	Moderate to severe: clay texture.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: clay texture.
*Juget: JrF—For Rock outcrop part of JrF, see Rock outcrop.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less; slope.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less; slope.	Severe: bedrock at depth of 20 inches or less; slope.	Severe: bedrock at depth of 20 inches or less.
Kim—Mapped only with Nunn soils.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight to moderate: clay loam or sandy clay loam texture.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Slight to moderate: clay loam or sandy clay loam texture.
Kutch: KuD	Severe: bedrock at depth of 20 to 40 inches; slow permeability.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay texture; bedrock at depth of 20 to 40 inches.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Moderate to severe: soft shale at depth of 20 to 40 inches.
Laporte: LaE	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.

See footnote at end of table.

TABLE 7.—*Limitations of the soils for urban uses*—Continued

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfill [1]
Longmont: LoB	Severe: water table at depth of 1 to 2 feet; slow permeability.	Severe: water table at depth of 1 to 2 feet.	Severe: water table at depth of 1 to 2 feet.	Severe: water table at depth of 1 to 2 feet; high shrink-swell potential.	Severe: poorly drained; high shrink-swell potential.	Severe: clay texture; water table at depth of 1 to 2 feet.
Loveland: Lv	Severe: flooding hazard; water table at depth of 2 to 4 feet.	Severe: flooding hazard; rapid permeability below a depth of 3 feet.	Severe: flooding hazard; water table at depth of 2 to 4 feet.	Severe: flooding hazard.	Moderate: flooding hazard; moderate shrink-swell potential.	Severe: flooding hazard; sand and gravel at depth of 20 to 40 inches.
Made land: Ma. Properties too variable to be estimated.						
Manter: MdA, MdB, MdD.	Slight	Severe: rapid permeability in substratum.	Slight above depth of 3 feet; severe below depth of 3 feet; sandy substratum.	Slight	Slight	Slight: pollution hazard in some places because of rapid permeability.
Manvel: Me	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Slight	Slight	Slight.
McClave: Mm	Moderate to severe: water table at depth of 2½ to 5 feet.	Moderate to severe: water table at depth of 2½ to 5 feet; moderate permeability.	Moderate: clay loam texture; water table at depth of 2½ to 5 feet.	Moderate: water table at depth of 2½ to 5 feet; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: clay loam texture; water table at depth of 2½ to 5 feet.
Nederland: NdD	Slight where slope is 1 to 8 percent; moderate where slope is 8 to 12 percent	Severe: stones and cobbles; moderately rapid permeability.	Severe: stones and cobbles.	Moderate to severe: stones and cobbles; slope.	Moderate to severe: stones and cobbles.	Severe: stones and cobbles.
Niwot: Nh	Severe: flooding hazard; water table at depth of ½ to 1½ feet.	Severe: flooding hazard; water table at depth of ½ to 1½ feet; rapid permeability.	Severe: water table at a depth of ½ to 1½ feet.	Severe: flooding hazard; water table at depth of ½ to 1½ feet.	Moderate to severe: flooding hazard; water table at depth of ½ to 1½ feet.	Severe: flooding hazard; water table at depth of ½ to 1½ feet.
*Nunn: NnA, NnB, NuA, NuB, Nv. For Kim part of Nv, see Kim series.	Severe: slow permeability.	Slight where slope is 1 to 2 percent; moderate where slope is 2 to 3 percent.	Moderate to severe: clay and clay loam texture.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: clay and clay loam texture.

See footnote at end of table.

TABLE 7.—*Limitations of the soils for urban uses*—Continued

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfill [1]
*Nunn—Continued						
NuC, NuD	Severe: slow permeability.	Moderate where slope is 5 to 7 percent; severe where slope is greather than 7 percent	Moderate to severe: clay and clay loam texture.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: clay and clay loam texture.
Otero:						
Mapped only with Ascalon soils.						
Otero part of AoB, AoC, AoD.	Slight	Severe: moderately rapid permeability.	Slight	Slight	Slight	Slight.
Otero part of AoE	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Severe: moderately rapid permeability; slope.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 precent.	Moderate: slope.
*Peyton: PgE	Slight where slope is 5 to 8 percent; moderate where slope is 8 to 15 percent; severe where slope is greater than 15 percent.	Severe: rapid permeability; slope.	Moderate where slope is less than 15 percent; severe where slope is greater than 15 percent; gravelly material.	Slight where slope is 5 to 8 percent; moderate where slope is 8 to 15 percent; severe where slope is gretaer than 15 percent.	Slight where slope is to 5 8 percent; moderate where slope is 8 to 15 percent; severe where slope is greater than 15 percent.	Moderate: rapid permeability; slope.
For Juget part of PgE, see Juget series.						
Pinata: PrF	Severe: bedrock at depth of 20 to 40 inches; slope.	Severe: stones; bedrock at depth of 20 to 40 inches; slope.	Severe: stones; bedrock at depth of 20 to 40 inches.	Stones; moderate shrink-swell potential; moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Stones; moderate shrink-swell potential; moderate where slope is less than 15 percent; severe where slope is greater than 15 percent.	Severe: bedrock at depth of 20 to 40 inches.
For Rock outcrop part of PrF, see Rock outcrop.						
Renohill:						
ReD	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less, high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: bedrock at depth of 20 inches or less.
RnB, RnD	Severe: bedrock at depth of 20 to 40 inches	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: soft shale at depth of 20 to 40 inches.

See footnotes at end of table.

TABLE 7.—*Limitations of the soils for urban uses*—Continued

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfill [1]
Rock outcrop: Ro. Severe limitation for all uses; exposed bare rock at the soil surface.						
*Samsil: SaD, SeE. For Shingle part of SeE, see Shingle series.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less; high shrink-swell potential.	Severe: bedrock at depth of 20 inches or less; high shrink-swell potential.	Severe: soft shale at depth of 20 inches or less.
*Shingle: SgE. For Gaynor part of SgE, see Gaynor series.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: bedrock at depth of 20 inches or less.	Severe: soft shale at depth of 20 inches or less.
Sixmile: SmF.	Severe: bedrock at depth of 20 to 40 inches; slope.	Severe: bedrock at depth of 20 to 40 inches; slope.	Severe: stones on surface; bedrock at depth of 20 to 40 inches; slope.	Moderate where slope is 10 to 15 percent; severe where slope is greater than 15 percent; bedrock at depth of 20 to 40 inches; stones.	Moderate where slope is 10 to 15 percent; severe where slope is greater than 15 percent.	Severe: stones; bedrock at depth of 20 to 40 inches; slope.
Terrace escarpments: Te. Properties too variable to be estimated.						
Valmont: VaB, VaC, VcC.	Slight.	Severe: moderately rapid permeability in substratum; slope.	Moderate: cobbles and gravel at depth of 20 to 40 inches.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.	Severe: cobbles and gravel at depth of 20 to 40 inches.
VcE.	Slight where slope is 5 to 8 percent; moderate where slope is 8 to 15 percent; severe where slope is more than 15 percent.	Severe: moderately rapid permeability in substratum; slope.	Moderate: cobbles and gravel at depth of 20 to 40 inches.	Moderate to severe: moderate to high shrink-swell potential; slope.	Moderate to severe: moderate to high shrink-swell potential; slope.	Severe: cobbles and gravel at depth of 20 to 40 inches.
*Weld: WdB, WeB, WlA, WlB, WoB, WoC. For Colby parts of WoB and WoC, see Colby series, mapping units CoB, CoC.	Severe: slow permeability.	Slight where slope is 0 to 2 percent; moderate where slope is 2 to 5 percent.	Severe to moderate: clay and clay loam texture.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe to moderate: clay and clay loam texture.

[1] Onsite studies of the underlying strata, water tables, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 5 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate.

Formation and Classification of the Soils [9]

In this section the factors that affect the formation of the soils in the Boulder Area are discussed and the major processes of soil formation are described. Finally, the classification of the soils in the taxonomic system is given and the character of each group of soils in the categories above the soil family level is briefly described.

Factors of Soil Formation

Soil is a natural dynamic body at the surface of the earth that has characteristics resulting from action of the forces of the environment upon parent materials over a period of time. The character of the soil in any landscape differs from place to place, depending upon the nature and intensity of the factors that controlled its development.

Five major factors are recognized as being influential in the development of the soil in its virgin state at any specific location. Briefly stated, these five are climate, biological activity, time, relief, and parent material. All of these factors are highly complex. There are many kinds of climate and many combinations of biological forces. Parent materials vary widely in physical, chemical, and mineralogical properties, and there are great differences in the length of time that they have been subjected to the effects of climate and biological activity.

Although the five factors just discussed have been traditionally accepted as those that influence soil development, a sixth factor—man and his activities—must be added to complete that list. Man's activity is frequently, but not always, destructive. He directly alters the character of the soil by cultivation, fertilization, irrigation, or drainage or by removal of parts of the soil. He alters the soil indirectly by controlling water movement or vegetative cover.

The history of the development of soil characteristics and the study of the interaction of the formative forces is called soil genesis. The characteristics themselves constitute the soil's morphology. Thus, the color of the soil is one feature of soil morphology. The reason that such a color developed is part of the soil's genesis.

It is impossible to precisely reconstruct the history of a soil's development from the limited data available at any one location. To do so, it would be necessary to observe the soil and its environment throughout the entire period of the development, which for most soils is at least several thousand years. Since this is impossible, reconstruction of the soil's genesis must be based on interpretations. These are drawn from the soil's morphology and our accumulated knowledge of how much morphology could most logically have developed.

The system of soil classification used in the United States is based on properties of the soil that can be observed or measured. The soil properties are used to group similar soils or separate those that are dissimilar. Selection of the kinds and magnitudes of properties that are to be considered as definitive between soils is guided by our understanding of soil genesis. Thus, the two are closely interrelated and both are essential to a good classification system.

In the following sections a general evaluation of the factors that influence soil development in the Boulder Area is attempted, and the manner in which soil morphology has been used to group the soils into the units of classification is outlined.

Climate

The climate of the Boulder Area is of a semiarid, continental type. Winters are cold and dry, and summers are cool and relatively dry. Mean annual air temperature from measurements at the Longmont weather station is 48.1° F., and mean summer air temperature is 68.4°. Elevation within the survey area is lowest at the eastern border and increases to the west. Air temperature and annual precipitation conform to the same pattern; the climate is increasingly cooler and more moist as elevation increases. Precipitation at the Longmont station is about 12.0 inches per year, but along the front of the foothills it averages about 18 inches a year.

Eleven sites in the Boulder Area were selected for soil temperature measurements. These measurements yield a somewhat better evaluation of soil climate than do interpretations based on air temperature. These sites ranged in elevation from 5,230 feet to 8,120 feet. Mean annual soil temperatures calculated from measurements at a depth of 20 inches ranged from 53.1° at 5,230 feet elevation to 44.4° at 8,120 feet. Because of local site factors, such as moisture, aspect, and vegetative cover, it is not possible to talk about a precise covariant relationship existing between soil temperature and elevation; however, the decrease in mean annual soil temperature with

[9] By ARVAD J. CLINE, senior soil correlator, Soil Conservation Service.

a rise in elevation is consistent, and the decrease is about 0.3° for each 100 feet of increase in elevation.

Mean summer soil temperature was less consistent than mean annual soil temperature. The mean summer temperature ranges from 70.2° at 5,230 feet elevation to 57.0° at 8,120 feet. This is an average decrease of about 0.4° for each 100 feet rise in elevation.

The Boulder Area receives its greatest precipitation during spring and summer. Fall and winter are comparatively dry, and total precipitation during the period December through February averages only 2.0 inches.

Precise soil moisture data are not available for the Area, but a general picture of soil moisture fluctuation can be obtained from a comparison of the precipitation and evapotranspiration. In December, precipitation exceeds losses from evapotranspiration, and some moisture is stored within the soil. This condition continues through winter and into late April or early May, when evapotranspiration rates start to increase rapidly. In spite of the increased precipitation during spring and summer, evapotranspiration exceeds the amount of moisture received as rain, and by mid or late July the soils are dry except for relatively brief periods following summer rain.

The effect of climate on soil development in the Boulder Area can only be approximated by inference from our present knowledge of climate variations. Recorded weather data for the Area characterize only the last 50 to 60 years, though development of many soils of the Area has required thousands of years. We cannot assume, therefore, that the recorded data represent the climate for all, or even a major part, of the time that a particular soil was developing. It is possible, though, to draw certain parallels between general characteristics of the climate and the characteristics of the soils of the Area.

Amount of water available and distribution of supplies of soil moisture relative to soil temperature and the periods of maximum biological activity are of prime importance to soil genesis. The combination of these factors plays a major role in the accumulation of organic matter in soil, in the physical movement of substances in suspension or solution, and in controlling the rate of chemical processes. Based upon our present knowledge of these combinations of factors, as applied to the Boulder Area soils, we can conclude that for a considerable period of the soils' history, the climate in the Area was more moist than the recorded present precipitation at the Longmont station indicates.

The depth to which water moves down through the soil is often more significant to our evaluation of soil genesis than is the amount of yearly precipitation. In areas of higher elevation within the survey area the amount of yearly precipitation is greater and the evapotranspiration rate is less than in areas of lower elevation. A somewhat greater volume of soil moisture therefore is available for leaching processes at higher elevations, and soils of the Allens Park, Fern Cliff, and Goldvale series are leached of lime.

The relationship between temperature and soil genesis is more obscure, perhaps because the differences in soil temperature within the survey area are smaller, relatively, than the differences in soil moisture. Mainly, temperature is most noticeable in its control of biologic activity and its impact on physical soil properties.

Forty degrees Fahrenheit is commonly accepted as the temperature separating periods of low biotic activity from those of high activity. At the lowest elevations on soils of the Weld and Nunn series, the period that the soil temperature at a depth of 20 inches exceeds 41° is about 249 days, and the soils are rarely below 32° during the rest of the year. At the higher elevations on soils of the Fern Cliff series, the period that the soil temperature at a depth of 20 inches exceeds 41° is about 180 days, and the soils are at or slightly below 32° for about 70 of the remaining days. The periods in which genetic forces dependent upon high temperature are most effective are shorter for higher elevations than for lower ones.

Physical changes in the soil that result from freezing and thawing influence soil morphlogy and genesis. Certain forms of soil structure are enhanced by freezing and thawing, and these in turn, influence permeability, aeration, and resistance to erosion. Horizons that are frozen during winter affect moisture distribution and intake. All of these factors should be more active at the higher elevations than at the lower, unless the soil is insulated by a snow pack.

Mean annual soil temperature more or less than 47° is a criterion for separating some soils of the Boulder Area at the suborder level in the soil classification system. This parameter has not been directly related to other soil properties in the Area, but it does have a pronounced effect on cropping patterns and crop potentials because it largely determines planting dates, maturing dates, and rates of growth.

Biological activity

Biological activity that affects soil genesis in the Boulder Area can be divided into three major classes: (1) common plants; (2) burrowing animals, worms, and insects; and (3) micro-organisms. All of these affect the development of soils, but in different ways.

The natural vegetation of the area, or the vegetative changes introduced by the activity of man, has profoundly affected soil development. Its effects, however, cannot be entirely divorced from the effects of the activity of animal and insect life or that of micro-organisms. At any location an interdependence exists among all three of the classes of life forms, and it is the composite of their activities and natures that has controlled soil genesis.

Two major kinds of native vegetation can be identified in the Boulder Area, and the line of demarcation between them is comparatively sharp. The plains area to the east of the foothills is almost entirely grassland having only scattered growths of cottonwood and similar trees that act as windbreaks for farmsteads or are along the drainageways and the irrigation canals. The foothill area in the western part of the survey area has scattered clumps of trees, but is dominately brush and grass. Trees grow on the north-facing slopes of the foothills, and stands of timber cover the mountain slopes.

The two different types of vegetation, grass and timber, have had a pronounced effect on soil development. Where landscapes are predominantly grassland of sufficient age, the soils usually have dark-colored, neutral to mildly alkaline surface horizons that have more than 1 percent organic matter. Such horizons may include the A1 and part of the B2 horizons. The dark color and high organic-

matter content of these horizons are the result of the partial decomposition of relatively large yearly additions of organic matter to the soil by the above-ground parts and the extensive root systems of the grass. The Nunn series is a typical grassland soil that has an Ap-horizon 10 inches thick and a B2 horizon 8 inches thick, both of which are dark colored.

Where landscapes have been covered by good growths of timber for sufficient time, the soils have a surface horizon that consists of undecomposed or partially decomposed organic horizons, very thin, dark-colored A1 horizons, and thick, light-colored, eluvial A2 horizons. In the Boulder Area the A1 and A2 horizons are generally slightly acid to neutral in reaction, but the O horizon may be somewhat more acid. Soils such as Fern Cliff also have a relatively thick A&B horizon of silicate clay accumulation. The genesis of this A&B horizon is not clearly understood, but it appears to be part of the B2t horizon that is being converted to an A2 horizon. The consistent occurrence of the A&B horizon and its character have prompted some soil scientists to propose that it represents a major shift in vegetation within the soil's genetic history from grassland to forest, with a corresponding alteration of a typical grassland soil to a typical forested soil.

In the foothill areas the relationships outlined above between vegetative cover and kind of soil are those most commonly found; however, exceptions do occur. It must be kept in mind that forests are not rapidly replaced once they have been destroyed. In the early history of the western states, part of the original timber was destroyed by fire; by clearing for fields; or by cutting for lumber, fenceposts, and firewood, braces for mines, or railroad ties. In consequence, it is not unusual to find types of soil indicative of timber cover in areas that are now grassland.

The effect of burrowing animals and insect life on soil development in the Boulder Area is not as easily demonstrated, and their major points of activity are apt to be localized. Rodent activity is apt to be destructive to soil horizonation, but it is also apt to be short lived. The common prairie dog has been nearly eradicated from this Area, but some areas of soil mixing within old prairie dog towns can still be found in grassed areas.

The action of insects and worms is more general and more constant. Large numbers of these creatures thrive in the soils of the Boulder Area. Some selectivity is shown by various kinds of insects for particular kinds of soils, and generally, such selectivity can be related to type of vegetation, moisture supply, texture, and soil reaction.

Little is known precisely about the microbiology of the Area. Certainly its overall importance is great. The micro-organisms are particularly sensitive to soil reaction and aeration. Consequently, types differ between grasslands and forests, and between well-drained and poorly drained sites. A symbiotic relationship between micro-organisms and certain types of plants exists in soils of good drainage throughout the Area. Anaerobic types prevail in the more poorly drained soils, while molds and fungus that are tolerant of acidity are found under heavier stands of timber.

Time

Time refers to the length of time the other soil-forming factors have been active. In most situations, thousands of years are required for development of well-expressed horizons below the surface layer. The older soils in the Area generally have clearly expressed A and B horizons and horizons where calcium carbonate has accumulated. Soils that are thought to be young have weakly expressed horizons, and in most places they lack a B horizon. The chronological age of the soil at a particular location is not easily assessed, however, and the age of the soil usually can be stated only in relative terms based on studies of soil morphology and geomorphology.

Precise data on the chronological age of the soils of the Boulder Area are lacking, and therefore the landscapes have been grouped into three general age groups.

The youngest of these are the flood plains, low terraces, and recent alluvial fans that are forming in and along the sides of major drainage channels. These are very young sediments, and in many instances, deposition of sediments is still taking place on these landscapes. They are so youthful that soil development has not had time to produce distinct horizonation other than a darkening and enrichment of the surface horizon by the addition of organic matter. Soils of the Loveland series are representative of this age group.

The second group includes the broad interstream divides or terrace levels that have originated as fans at the base of the Rocky Mountains, as old eolian deposits, or as terrace systems along old drainage courses. These landscapes as they exist today are remnants of previously more extensive deposits that have been cut by modern-age drainage systems and partly eroded away. Most of the soils have distinct B horizons of silicate clay accumulation, and where the parent material contained carbonates, they have a continuous horizon of secondary carbonate accumulation. Soils of the Nunn series are representative of this age group.

Some landscapes of this second general age group are thought to be much older than others. Paleosols having distinct B horizons of clay accumulation have been found 5 to 15 feet below the present land surfaces, on which the modern soils also have distinct horizons of clay accumulation. Two periods of soil formation separated by a period of sediment deposition have occurred in these areas. The age of the modern soil obviously is much less than the time since the buried paleosol started to develop. On the other hand, it is thought that some landscapes of this second general age group were not covered by the sediments overlying the paleosols just mentioned. In this latter situation, if the land surface has not been strongly eroded, the total time available for soil formation could be the sum of the time necessary to form the buried paleosol, the time required for deposition of the sediments overlying the paleosol, and the time required to form the modern soil in the sediments overlying the paleosol. It is believed that landscapes dominated by soils of the Weld series are of this nature.

The third group of landscapes includes those areas in which soil parent materials have weathered more or less in place from bedrock. The ages of such landscapes are known with even less certainty than those of the second general group, but they clearly may be very old or very

young. That some of these landscapes may be very old is indicated by the presence of some small areas of extremely thick Boralfs in the foothills. Areas of these soils are too small to map but they are of interest because the base of the horizon of silicate clay accumulation (B2t horizon) commonly is more than 10 feet below the surface. At the young end of the range are landscapes in which the soils have thin or weakly expressed horizons, such as soils of the Sixmile and Baller series.

Relief

In the Boulder Area soil genesis is affected by relief, mainly as a result of the control of soil moisture by landform or slope gradient. Steepness of the slope, position relative to other kinds of soils, and the shape of the surface of the soil all affect supplies of soil moisture, and subsequently the genesis of the soils.

Steeply sloping areas lose much of the yearly moisture supply, and may erode each year as well. Usually such erosion is not rapid enough to be readily noticeable in a given year, but over a long period of time it can remove enough soil to prevent distinct soil horizons from forming. The shallow soils of the Samsil and Shingle series are examples.

Concave areas that tend to concentrate runoff, or areas that receive additional runoff from higher lying areas, tend to develop thick soil profiles. Color, content of organic matter, and thickness of a dark-colored A horizon are particularly related to slope and landform. Soil particles that are carried in suspension by runoff water coming from adjacent areas tend to settle out in concave areas where velocity of flow decreases. Thus, the thickening of a dark-colored surface horizon in such soils as Calkins and McClave is as much the result of the deposition of eroded material from the adjacent soils as it is the increased plant growth resulting from a more plentiful moisture supply.

In the foothill areas, slope aspect is often the controlling factor in the kind of vegetation that can grow, and this affects the kind of soil that develops. Mean annual soil temperature is 2 to 4 degrees colder on north slopes than on south slopes. Equally important is the larger accumulation of snow on north slopes of the Area, and its persistence in spring. Summer precipitation is more effective on the north slopes because of lower evapotranspiration. As a result of all these factors, north-facing slopes are frequently timbered, but south-facing slopes are not.

The effect of relief on the control of wind direction and velocity is local and cannot be readily expressed in general terms applicable to the entire Boulder Area. The predominant wind direction in this Area is from the west, northwest, and southwest, and therefore, east, northeast, and southeast slopes are slightly less subject to drying and less susceptible to wind erosion.

Parent material

A wide variety of parent materials are available for soil formation in the Boulder Area. The chemical, physical, and mineralogical character of these parent materials determines their influence on the development and properties of the soil. Some general observations about characteristics of the parent materials can be made, but it must be emphasized that the observations made are general in nature and do not adequately characterize the parent materials at any specific location.

Alluvial sediments.—Young deposits along stream bottoms are extremely variable in physical, chemical, and mineralogical properties. Their most distinguishing property is their stratification and lack of uniformity.

Deposits left by drainage systems older than the present system vary in physical, chemical, and mineralogical properties from location to location, but they are generally uniform in any one location. These deposits are loamy in the upper part of the profile, and overlie beds of sand and gravel.

Deposits of Pleistocene age are of mixed mineralogy and contain calcium carbonate. These deposits are dominantly loams and clay loams that have gravel and cobbles throughout the profile.

Soils on alluvial sediments are as young as the Calkins soils and as old and mature as the Valmont soils.

Eolian deposits.—These wind deposits differ from place to place in their mineralogical composition but are relatively uniform in chemical and physical properties. Textures are dominantly loam, silt loam, or sandy loam. Most of these deposits contained calcium carbonate when first laid down. Soils of the Weld and Colby series are representative of soils in eolian deposits.

Olive and gray sedimentary rocks.—Soil parent material from these rocks weathered in place or were locally transported. They vary in texture but are dominantly loam, clay loam, or clay. Hues are dominantly 10YR or yellower. In most places the materials are calcareous, and they commonly contain gypsum or salts of sodium. Soils of the Samsil, Renohill, and Hargreave series are representative of soils weathered from these rocks.

Red sedimentary rocks.—Soil parent material from these rocks include those weathered in place and those that have been transported, but which retain most of the distinguishing characteristics of the materials weathered in place. Textures are dominantly loam and sandy loam. Hues range from 5YR to 10R. Most of the materials contain significant amounts of calcium and magnesium salts that are readily soluble in water, but materials weathered from red arkosic sandstone are free of both lime and salts. Soils of the Nederland, Pinata, and Sixmile series are representative of soils in materials weathered from these rocks.

Crystalline rocks.—Soil parent materials from these rocks have weathered in place or have been transported short distances. Materials weathered from granite are usually coarse textured or moderately coarse textured, are noncalcareous, and contain a large proportion of medium and coarse angular sand and fine or very fine gravel. Soils of the Juget series formed in these materials. Materials weathered from gneiss and schist are medium textured or moderately fine textured, are noncalcareous, and contain moderate amounts of mica. Soils of the Fern Cliff series formed in materials weathered from gneiss and schist.

Classification of Soils

In the taxonomic system of soil classification used in the Boulder Area the soils are placed in various classes

on the basis of similarity of their properties. All the soils in any one class have certain morphological characteristics in common that distinguish those soils from all others. These are called differentiating characteristics.

Six levels of generalization (categories) are used in the soil classification system. From the highest to the lowest level of generalization each succeeding category contains more classes and the classes are more narrowly defined. The categories are identified, from top to bottom, as orders, suborders, great groups, subgroups, families, and series. For purposes requiring the most detailed information about soils, the soil series are the most useful taxonomic classes. For less detailed purposes, the families or the subgroups may be adequate and more easily used. For still more general uses of soil information, such as comparison of soils in the Boulder Area with those in other parts of the United States or the world, the great groups, suborders, or orders may be the best levels of generalization.

Table 8 shows the classification of each soil series of the Boulder Area by family, subgroup, and order. The categories and the classes of the system that are represented by soils in this survey are described in the paragraphs that follow.

ORDERS, SUBORDERS, AND GREAT GROUPS are classes based on relatively broad sets of differentiating criteria designed principally to bring together soils of similar horizonation, similar genesis, and similar environment. They are broad groupings and are most useful in showing general soil differences within the survey, in understanding the basic genetic processes active in the Area, and in relating soils of the survey area to other soils of the world. Their value for designing specific management practices is limited, but phases of these classes can be useful for county, state, or national planning.

In the following paragraphs the five orders represented in the Boulder Area, and the suborder and great group subdivisions within each are briefly discussed.

Entisols.—These are the soils of the Area that are so young they have not had time to develop distinct genetic horizons. They have only slight darkening of the surface horizon or an irregular accumulation of soluble salts. There may be considerable physical or chemical difference between strata of these soils, but the differences are inherited from the parent material and are not the result of soil development. The common characteristics of Entisols is a lack of distinguishing genetic horizons.

In the Boulder Area the only suborder of Entisols is the Orthents. These are well-drained soils that have textures finer than loamy fine sand, and that have an organic-matter content that is greatest in the surface horizon and that decreases regularly with depth. The only great group of Orthents represented in the Boulder Area is the Torriorthents. These are the Orthents of dry areas where supplies of soil moisture are limited.

Inceptisols.—These are young soils that have more horizon development than the Entisols. In the Boulder Area they are poorly drained soils. Their subsoil has been partly altered by the weathering and segregation of iron compounds under conditions of a fluctuating water table, and they have a consistent accumulation of exchangeable sodium in their surface horizon.

In the Area this order is represented by the Aquepts at the suborder level, and the Halaquepts at the great group level. The Aquepts are the poorly drained Inceptisols. The Halaquepts are the Aquepts that have an accumulation of detrimental amounts of sodium in their surface horizon.

Aridisols.—The Aridisols are the light-colored, well-drained soils of arid and semiarid regions that have been in place long enough to have developed distinct genetic horizons. Although they are primarily soils of grasslands, the decomposition of organic matter in the soil has more or less equaled the yearly additions. In consequence, they have not developed the dark surface horizons that characterize the Mollisols. In the Boulder Area these soils may be associated with Mollisols, but they generally occupy those parts of the landscape where runoff or texture has restricted entry of moisture into the soil.

The two suborders of the Aridisols are the Orthids and Argids. Both are represented in the Boulder Area. Orthids are those Aridisols that lack an illuvial accumulation of silicate clay in the B horizon. The only great group of Orthids represented in the Area is Camborthids. These are Orthids that have a B2 horizon showing alteration but not illuviation.

The Argids are those Aridisols that have a B2 horizon of illuviated silicate clay. In the Area the Haplargid is the only representative of this suborder.

Mollisols.—The Mollisols are soils of humid to subhumid regions that are characterized by thick, dark-colored, friable surface horizons in which plentiful supplies of organic matter have accumulated. This accumulation is the result of the partial decomposition, in the presence of a predominance of bivalent cations, of relatively large yearly additions of plant materials to the surface horizon. The common characteristic of Mollisols is the darkened, friable, base-rich surface horizon that soil scientists refer to as a mollic epipedon.

Three suborders of Mollisols are represented in the Area. The Ustolls are the well-drained Mollisols that are in the warmer parts of the Area generally below elevations of about 7,500 feet. They have mean annual soil temperatures that are warmer than 47° F. The Borolls are the well-darined Mollisols that are in the colder parts of the survey area above an elevation of 7,500 feet. Their mean annual soil temperature is less than 47°, but their mean summer soil temperature is warmer than 50° Aquolls are the poorly drained Mollisols that are saturated with water for a significant part of each year.

Haplustolls, Argiustols, and Paleustolls are all subdivisions of Ustolls represented in the Boulder Area. Briefly stated, the Haplustolls are Ustolls that lack a horizon of silicate clay accumulation. Argiustolls contain a horizon of silicate clay accumulation that shows gradual increase of clay at its upper margin. Paleustolls contain a horizon of clay accumulation that has abrupt and relatively great increase in clay at the upper boundary.

In the Boulder Area the Borolls are subdivided into Haploborolls and Argiborolls. The Haploborolls lack a horizon of silicate clay accumulation. The Argiborolls have a genetic horizon of silicate clay accumulation.

Alfisols.—The Alfisols are light-colored soils of humid to subhumid areas that have a horizon of silicate clay

TABLE 8.—*Classification of soils in Boulder Area, Colorado*

Series	Current classification system		
	Family	Subgroup	Order
Allens Park	Fine-loamy, mixed	Typic Eutroboralfs	Alfisols.
Ascalon	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Baller	Loamy-skeletal, mixed, mesic	Lithic Haplustolls	Mollisols.
Calkins	Coarse-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Colby [1]	Fine-silty, mixed, (calcareous), mesic	Ustic Torriorthents	Entisols.
Fern Cliff	Fine-loamy, mixed	Psammentic Eutroboralfs	Alfisols.
Gaynor	Fine, montmorillonitic, (calcareous), mesic	Ustic Torriorthents	Entisols.
Goldvale	Fine, montmorillonitic	Typic Eutroboralfs	Alfisols.
Hargreave	Fine-loamy, mixed, mesic	Aridic Arguistolls	Mollisols.
Heldt	Fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Juget	Sandy-skeletal, mixed	Lithic Haploborolls	Mollisols.
Kim	Fine-loamy, mixed, (calcareous), mesic	Ustic Torriorthents	Entisols.
Kutch	Fine, montmorillonitic, mesic	Torrertic Arguistolls	Mollisols.
Laporte	Loamy, mized, mesic	Lithic Haplustolls	Mollisols.
Longmont	Fine, montmorillonitic, (calcareous), mesic	Aeric Halaquepts	Inceptisols.
Loveland	Fine-loamy over sandy or sandy-skeletal, mixed, (calcareous), mesic.	Typic Haplaquolls	Mollisols.
Manter	Coarse-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Manvel	Fine-silty, mixed, (calcareous), mesic	Ustic Torriorthents	Entisols.
McClave	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Nederland	Loamy-skeletal, mixed, mesic	Aridic Argiustolls	Mollisols.
Niwot	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Nunn	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Otero	Coarse-loamy, mixed, (calcareous), mesic	Uatic Torriorthents	Entisols.
Peyton	Fine-loamy, mixed	Aridic Argiborolls	Mollisols.
Pinata	Clayey-skeletal, mixed	Typic Eutroboralfs	Alfisols.
Renohill [2]	Fine, montmorillonitic, mesic	Ustollic Haplargids	Aridisols.
Samsil	Clayey, montmorillonitic, (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Shingle	Loamy, mixed, (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Sixmile	Fine-loamy, mixed, (calcareous), mesic	Ustic Torriorthents	Entisols.
Valmont	Clayey over loamy-skeletal, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Weld	Fine, montmorillonitic, mesic	Aridic Paleustolls	Mollisols.

[1] Colby, wet (*CsB*) is a taxadjunct to the Colby series.

[2] Renohill loam (*EeD*) is a taxadjunct to the series as a paralithic contact is present at a depth of 10 to 20 inches.

accumulation and are more than 35 percent base saturated. In the Boulder Area they are represented by the timbered soils.

The Boralfs are the only suborder of Alfisols represented in the Area. These are Alfisols having a mean annual soil temperature of less than 47°. Eutroboralfs are the only representatives of the Boralfs present in the survey. They are Boralfs that are more than 60 percent base saturated.

SUBGROUPS, FAMILIES, AND SERIES are the most detailed categories of the taxonomic classification system. The series is the most detailed, and differences between classes at this level are drawn on properties such as color, structure, texture, reaction, consistence and thickness of individual soil horizons. The soil series provides the maximum amount of information about the soil and has the greatest use of determining correct soil use and management practices.

Families are groups of soil series within subgroups. Soils in a family have similar chemical and physical properties that affect their responses to management and manipulation for use. They are groups of series and are less homogeneous than the series themselves. Nevertheless, the response of phases of soils in a family are nearly enough the same to meet many needs for practical interpretation of such responses.

Like the orders, suborders, and great groups, the subgroups are strongly biased toward soil genesis. They are the category having a strong genetic bias and are an important category for serious students of soil genesis and classification, as well as being of importance for broad planning of soil use.

In the following paragraphs a brief description of the major characteristics of the soils in each of the subgroups recognized in this study is given. The character of each of the individual series is described in another section of this survey and is not repeated here.

Ustic Torriorthents.—Soils of the Colby, Gaynor, Kim, Manvel, Otero, Samsil, Shingle, and Sixmile series are all representatives of this subgroup. These are moderately coarse textured to fine textured, well drained or moderately well drained soils of grasslands. They are characterized by a light-colored A horizon and are calcareous throughout the profile. Depth to bedrock in this group of soils ranges from 10 to more than 60 inches. The content of organic carbon decreases regularly with depth. Mean annual soil temperature is warmer than 47° F., and mean summer soil temperature is warmer than 59°.

Aeric Halaquepts.—Soils of the Longmont series are the only representatives of this subgroup. These are fine-texteured, poorly and somewhat poorly drained soils of grasslands. They are characterized by a light-colored, very strongly alkaline A horizon that contains more than 15 percent exchangeable sodium. The strongly mottled C horizon contains some visible evidence of salt accumulation. The content of exchangeable sodium exceeds 15 percent in the surface horizon but decreases with depth. Mean annual soil temperature is more than 47°, and mean summer soil temperature is more than 59°.

Ustertic Camborthids.—Soils of the Heldt series are the only representatives of this subgroup. These are fine-textured, well-drained, grassland soils. They are characterized by a light-colored, calcareous A horizon, a B2 horizon showing evidence of alternating in the form of higher chroma and moderate grade of structure, and a fine-textured C horizon. There are horizons of secondary carbonate accumulation. Mean annual soil temperature is more than 47°, and mean summer soil temperature is more than 59°.

Ustollic Haplargids.—Soils of the Renohill series are the only representatives of this subgroup. These are well-drained grassland soils. They are characterized by a thin, dark-colored A horizon, a fine-textured B2t horizon, and a calcareous C horizon that has subhorizons of secondary carbonate accumulation. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Typic Haplaquolls.—Soils of the Loveland and Niwot series are the representatives of this subgroup. These are medium textured to moderately fine textured, poorly drained meadow soils that overlie beds of sand and gravel. They are characterized by a dark-colored, calcareous to noncalcareous A horizon, and a strongly mottled C horizon. An unconformable sand and gravel IIC horizon is between depths of 10 and 40 inches. The content of organic carbon in the surface horizon is above 0.8 percent. Mean annual soil temperature is more than 47°, and mean summer soil temperature is more than 59°.

Cumulic Haplaquolls.—Soils of the Calkins and McClave series are representatives of this subgroup. These are moderately coarse textured to moderately fine textured, poorly drained and somewhat poorly drained, meadow soils. They are characterized by a thick dark-colored A horizon that is mottled in the lower part. The content of organic carbon is above about 0.8 percent in the A horizon, which exceeds 24 inches in thickness. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Lithic Haplustolls.—Soils of the Laporte series are representatives of this subgroup. These are moderately coarse textured to moderately fine textured, well-drained, grassland soils. They are characterized by a dark-colored A horizon and a light-colored, moderately coarse textured to moderately fine textured, calcareous C horizon that rests on bedrock at a depth less than 20 inches. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Aridic Argiustolls.—Soils of the Ascalon, Hargreave, Manter, Nederland, Nunn, and Valmont series are all representatives of this subgroup. These are moderately coarse textured to fine textured, well-drained, grassland soils. They are characterized by a dark-colored A horizon, a B2t horizon, and a C horizon that contains subhorizons of secondary carbonate accumulation. Dark-colored mollic epipedons are less than 20 inches in thickness. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Torrertic Argiustolls.—The soils of the Kutch series are the only representatives of this subgroup. These are fine-textured, well-drained, grassland soils. They are characterized by a dark-colored A horizon, a fine-textured B2t horizon, and a fine-textured, calcareous C horizon that contains subhorizons of secondary carbonate accumulation. These soils have a high shrink-swell potential, develop wide cracks when dry, and are subject to

some heaving when moist. Dark-colored mollic epipedons are less than 20 inches in thickness. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Aridic Paleustolls.—The soils of the Weld series are the only representatives of this subgroup. These are fine-textured, well-drained grassland soils. They are characterized by a dark-colored A horizon, a fine-textured B2t horizon, and a medium-textured, calcareous C horizon that has subhorizons of secondary carbonate accumulation. These soils have a large and abrupt change in the content of clay between the A and the upper part of the B2t horizon. Dark-colored mollic epipedons are less than 20 inches thick. Mean annual soil temperature is warmer than 47°, and mean summer soil temperature is warmer than 59°.

Lithic Haploborolls.—Soils of the Juget series are the only representatives of this subgroup. These are coarse-textured, excessively drained soils that support a mixed vegetation of grass and trees. They are characterized by a dark-colored A horizon and a coarse-textured C horizon. They overlie bedrock, which is at a depth of less than 20 inches. Mean annual soil temperature is less than 47°, but mean summer soil temperature is warmer than °.

Aridic Argiborolls.—Soils of the Peyton series are the only representatives of this subgroup. They are moderately fine textured, well-drained, grassland soils. They are characterized by a moderately dark colored A horizon, a B2t horizon, and a moderately coarse textured, noncalcareous C horizon. Dark-colored mollic epipedons are less than 16 inches thick. Mean annual soil tempeature is colder than 47°, but mean summer soil temperature is warmer than 59°.

Typic Eutroboralfs.—Soils of the Allens Park, Goldvale, and Pinata series are all representatives of this subgroup. These are medium-textured to fine-textured, well-drained, timbered soils. They are characterized by a light-colored A1 horizon, a moderately thick, light-colored, eluvial A2 horizon, a continuous transitional A and B horizon, and a continuous B2t horizon. Base saturation exceeds 60 percent. Mean annual soil temperature is less than 47°, and mean summer soil temperature is more than 59°.

Psammentic Eutroboralfs.—Soils of the Fern Cliff series are the only representatives of this subgroup. These are moderately coarse textured, well-drained, timbered soils. They are characterized by a light-colored A1 horizon, a moderately tihck, light-colored eluvial A2 horizon, and a B2t horizon in which the clay is accumulating in discontinuous lenses and seams in a coarser textured matrix. Mean annual soil temperature is less than 47°, but mean summer soil temperature is more than 59°.

General Nature of the Area

The Bolder Area is located along the east flank of the Colorado Front Range in the north-central part of the State. The eastern part of the Area is within the Colorado Piedmont section of the Great Plains physiographic province, and the western part lies within the Front Range section of the Southern Rocky Mountain province. The elevation of the Area ranges from about 4,900 feet along the eastern edge, to about 8,200 feet in the southwestern part.

The Area is drained by tributaries of the South Platte River. The major tributaries are St. Vrain Creek, Lefthand Creek, Boulder Creek, and Coal Creek. These streams originate in the mountainous part of the Area and flow through it in an easterly or northeasterly direction.

The principal towns are Boulder, Longmont, and Broomfield. Boulder in 1970 had a population of 66,870; Longmont, 23,209; and Broomfield 7,261. Smaller towns in the Area are Lafayette, Louisville, and Lyons.

Geology [10]

The most outstanding physiograpic feature of the Boulder Area is the abrupt wall-like mountain front forming the boundary between the Front Range and the Piedmont area (fig. 15).

The narrow foothills area along the western margins of the Piedmont is characterized by a series of folded and faulted sedimentary strata, the more resistent beds of which form prominent hogback ridges.

The foothills area at the base of the mountain front is characterized by numerous broad, gently sloping interstream surfaces that stand at various steplike levels above modern stream valleys. The high-level geomorphic surfaces usually occur as fan-shaped pediments mantled by coarse alluvial deposits. These deposits lie on erosion surfaces that truncate the titled strata of the foothills belt. Below these pediment surfaces, the modern streams generally occupy relatively wide and flat-floored valleys.

Geologic formations ranging from Precambran to Recent in age occur within the survey area. They consist of Precambrian metamorphic and igneous rocks; sedimentary rocks of Paleozoic and Mesozoic are; a few small bodies of igneous intrusive rock of Tertiary age; and unconsolidated surficial deposits of Quaternary (Pleiocene and Recent) age. The geologic formations present also include Boulder Creek and Silver Plume Granite of Precambrian age.

The most extensive sedimentary formations in the survey area are the Pierre Shale, the Fox Hills Sandstone, and the Laramie Formation. The Pierre Shale crops out just to the east of the foothills area and throughout the northeastern part of the Boulder Area. The Fox Hills Sandstone and the Laramie Formation crop out in the southeastern part of the county.

Sedimentary formations that are older than the Pierre Shale consist of a series of sandstone and shale beds, the standstone predominating. These formations crop out mainly as a series of hogback ridges in the relatively narrow foothills area along the mountain front. They include the Fountain Formation, Lyons Sandstone, Lykins Formation, Ralston Creek Formation, Morrison Formation, Dakota Group, Benton Shale, and Niobrara Formation.

The Quaternary deposits in the Boulder Area are of four principal kinds: alluvium, slope-wash colluvium, eolian silt and sand, and talus and landslide deposits.

[10] ALEX D. ELKIN, geologist, Soil Conservation Service, assisted in the preparation of this subsection.

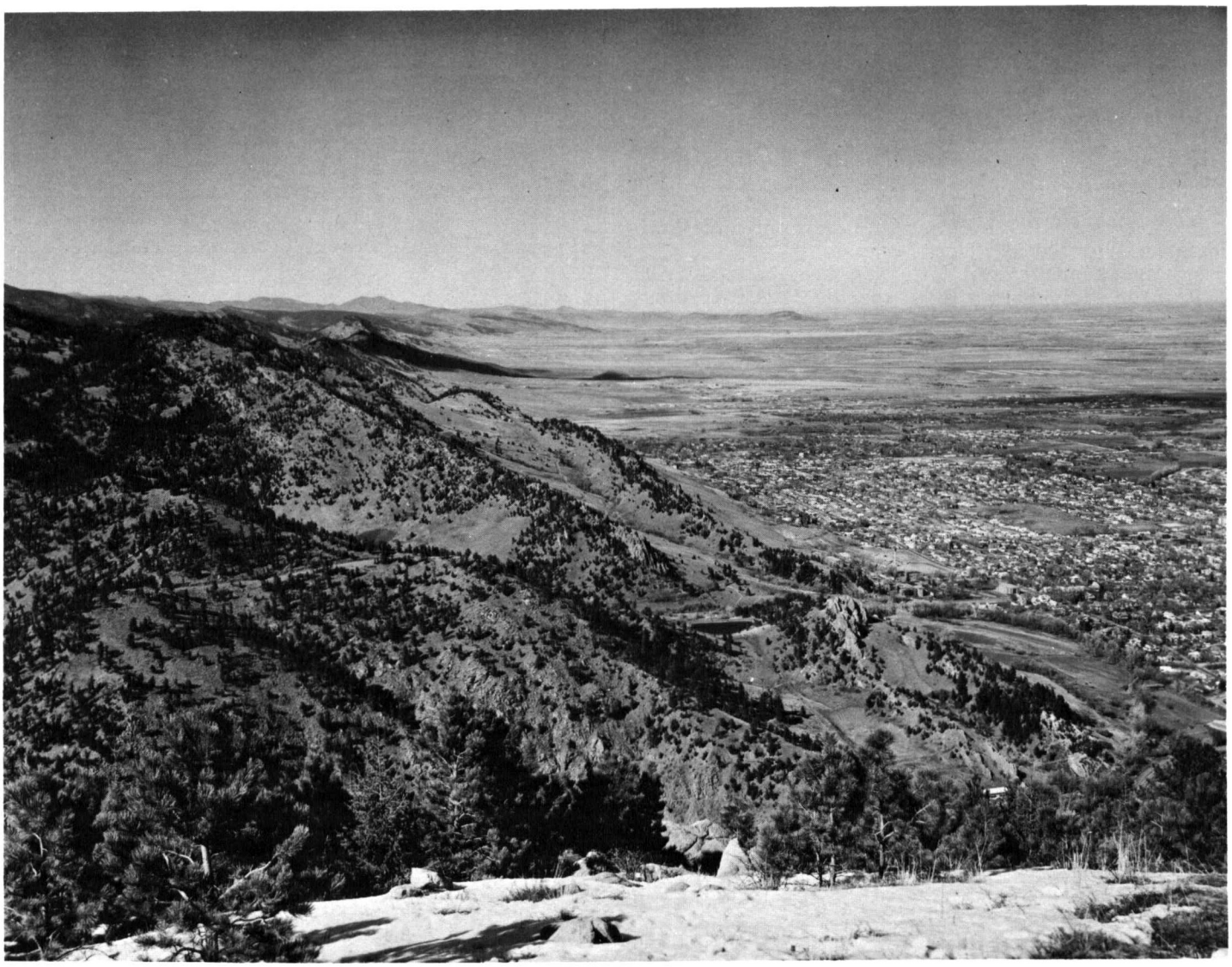

Figure 15.—**Landscape showing foothills meeting the plains and the city of Boulder in the foreground.**

These surface deposits were laid down during several geomorphic cycles that consisted of downward stream cutting, deposition of alluvium, erosion and deposition by wind, and soil development.

Climate [11]

The Boulder Area has mountain climate in the western part and a high plains, continental climate in the eastern part. Variations in temperature are wide. The average annual temperature in the mountainous part of the Area is lower than in the high plains, and the temperature increases from east to west in the plains part. Average annual precipitation also increases from east to west. In the eastern part of the Area, rainfall is light and humidity is low.

[11] Prepared from material by J. W. BERRY, State climatologist, National Weather Service.

Temperature and precipitation data for the mountainous part of the Area are not available. It can be said, however, that the differences in altitude and exposure create great variations in both temperature and precipitation. In general, temperatures are cooler at higher elevations, and northern exposures are cooler than southern exposures. The average frost-free period ranges from 90 to 110 days, and therefore, much of the mountainous part of the Area does not have a growing season of sufficient length to allow for crop maturation. Annual precipitation ranges from about 18 to 24 inches and increases with elevation. A large proportion of the precipitation is likely to be snow at higher elevations.

In the eastern part of the Area the climate is modified considerably from that expected of a typical high plains because of the nearby mountains in the west. The winds characteristic of the plains are reduced somewhat by the shielding effect of the mountains. There are areas near the mouth of large canyons, however, that are subject

to occasional damaging winds. At many times these winds are only local, but they are strong enough to cause damage to buildings, structures, and farmlands. They usually occur in the winter and spring, and velocities up to and exceeding 100 miles per hour have been reported at Rocky Flats south of Boulder.

Following is a brief discussion of the temperature and precipitation data for the eastern high plains part of the Area.

Precipitation.—Precipitation at Longmont and Boulder is shown graphically (fig. 16).

Average annual precipitation at Longmont is 12.03 inches; and at Boulder, it is 18.52 inches. Relative humidity is about 30 to 35 percent in summer, and about 40 to 50 percent in winter. Ordinarily, early morning humidity ranges from 55 to 60 percent in the summer, and from 60 to 70 percent in the winter.

Period of drought are frequent, particularly in the eastern part of the Area. These periods usually occur in fall and winter. In summer, thunderstorm activity originating in or near the mountains is frequent and at times severe, but in general, the storms are less severe than in the eastern part of the Area.

Temperature.—Winter temperatures are modified by the frequent occurence of warm downslope winds from the west. At Longmont in about 1 year in 2, the lowest temperature is lower than 10° F. below zero; at Boulder in about 1 year in 5, the lowest temperature is about zero. The average January temperature in Longmont is 27°; and in Boulder it is 32.7°.

In Longmont summer temperature reaches 100° about 1 year in 2; and in Boulder, about 1 year in 3. The average July temperature at Boulder is 73.6°, but at Longmont it is only 71.6°. These temperatures are accompanied by low humidity and therefore, are more comfortable than might be expected. Also, high daytime temperatures are followed by cool evenings and by nights usually below 60°.

The length of the growing season in Longmont is 140 days and in Boulder it is 148 days. At Longmont the average date of the first killing frost in fall is September 28; at Boulder it is October 4. The average date of the last killing frost in spring is May 11 at Longmont and May 9 at Boulder.

Farming

In 1954 the average siez farm in the Boulder Area was about 220 acres; in 1959 it was 320 acres; and in 1964 it was 370 acres. This increase reflects the trend to larger size farms, and is partly due to mechanization and an increasing ability to use both machinery and time effectively.

In 1959 about three-fourths of the farms were operated by owners or part owners; since that time, however, the number of tenant-operated farms has increased.

The irrigated farmland of the Area is capable of supporting a wide variety of crops. The main crops are corn, alfalfa, sugar beets, barley, oats, dry beans, and pasture grasses. Malting barley and such vegetable crops as sweet corn, cabbage, peppers, onions, red beets, pumpkins, cucumbers, and peas are well adapted to the soils of the Area and are grown on limited acreages.

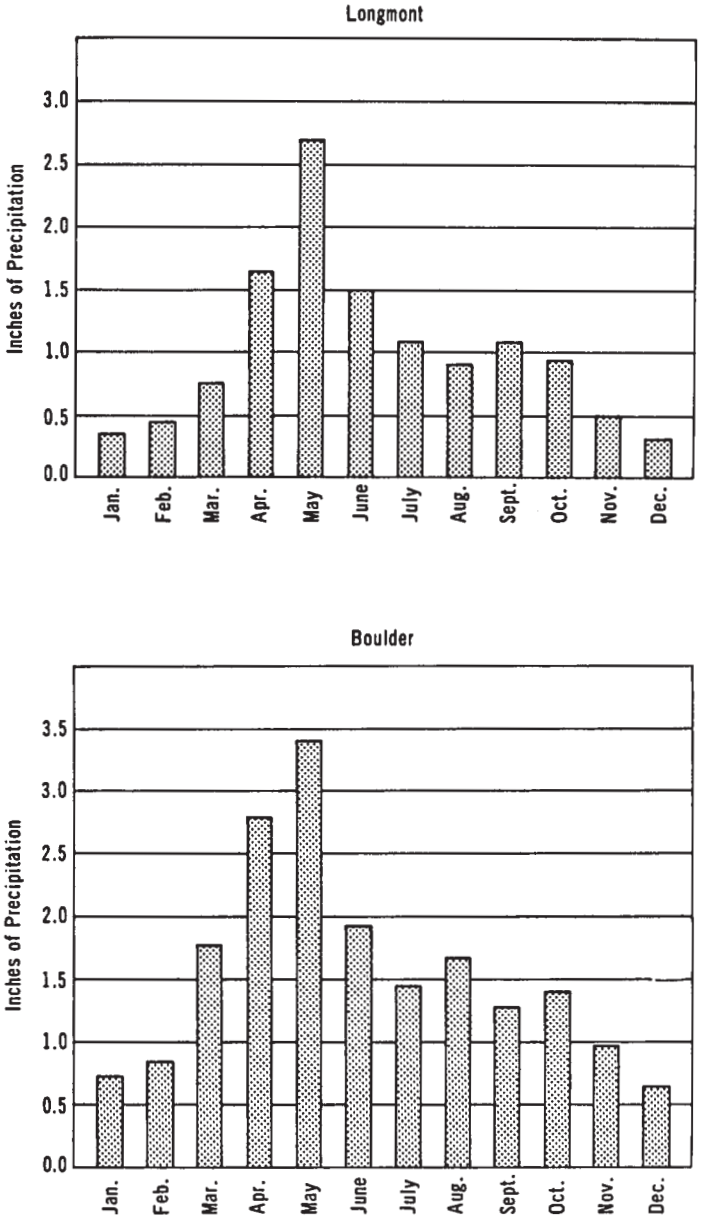

***Figure 16.*—Average monthly precipitation at Longmont and Boulder, Colorado.**

Most of the corn grown in the Area is used for silage at the local commercial feedlots, farm feedlots, and dairies. Sugar beets are processed at a sugar factory in Longmont. Cabbage, sweet corn, peppers, onions, and other fresh vegetables find a ready market in the Denver metropolitan area. Most of the red beets, pumpkins, cucumbers, and peas are processed at canning factories in nearby locations, and there are facilities for processing meat and dairy products locally and in Denver.

A small grain-summer fallow rotation is the main system of farming on the nonirrigated soils. Summer fallowing is necessary to store enough moisture for sustained high yields. Wheat is the principal crop, but barley and sorghum are also grown.

There are also some areas of native grasses that are used for grazing. Cattle have been the main type of livestock on range areas, but in recent years increasing numbers of pleasure horses graze these areas. In addition to cattle and horses, there are also significant numbers of sheep, hogs, and turkeys that use the feed crops of the Area.

Transport facilities.—The Boulder Area is served by the Colorado and Southern Railway Company, which has depots at Broomfield, Boulder, and Longmont. U.S. Highway No. 287 traverses the Area from north to south, and there are several access points to Interstate Highway No. 25, which is a few miles east of the Area. In addition, there are many miles of well-graded graveled or hard-surfaced county roads and State highways through the Area, including a four-lane divided highway between Boulder and Denver. The municipal airports at Broomfield, Boulder, and Longmont are capable of handling small- and medium-sized aircraft.

School facilities.—Several schools, colleges, and universities are in the Area or within easy driving distance. The University of Colorado is located at Boulder. Colorado State University is at Fort Collins, and the University of Northern Colorado is at Greeley. Denver University, Metropolitan State College, and Temple Buell College are located in Denver, and are all within a 50-mile radius of the Area. There are also many vocational schools nearby.

Trends in soil use.—The Boulder Area is rapidly changing from an intensively farmed irrigated area to an urban area of housing and light industry. In the past 10 years, the average population per square mile has increased from about 100 to 175. In the same period, the population of Boulder has increased by about 75 percent, and that of Longmont by about 97 percent.

Some of the reasons for this change are availability of employment, presence of educational facilities, favorable climate, and opportunities for summer and winter recreation. Regardless of reasons for this change, there has been increasing demand for soil, water, and other natural resources, and this trend is likely to continue.

Glossary

Aggregate. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Chiseling. Breaking or loosening subsoil with a chisel cultivator or chisel plow.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (See also Sand, Silt, and Texture.)

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Cobble. A rounded or partially rounded fragment of rock ranging from 3 to 10 inches in diameter.

Colluvium (colluvial material). A mixture of soil material and coarser material moved mainly by gravitation, creep, and local wash and deposited at the foot of slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure, but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. The soil ordinarily is tilled for at least one growing season to control weeds and to aid in the decomposition of plant residues.

Gravel. A rounded or angular fragment as large as 3 inches in diameter.

Green manure (agronomy). A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Mottling, soil. Irregular marking with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Nurse crop. A companion crop grown to protect some other crop sown with it; for example, a small grain is sometimes seeded as a nurse crop with clover.

Parent material. The horizon of weathered rock or partly weathered soil material from which a soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables a soil to allow water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid,* and *rapid.*

pH. See Reaction, soil.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is previsely neutral in reaction because it is neither acid nor alkaline. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. Surface drainage of rainfall or melted snow.

Salinity. The terms used to indicate salinity of the soils are based on the electrical conductivity of saturated soil extract as expressed in millimhos per centimeter at 25° C.

Salinity	*Mmhos. per cm.*
None	Less than 2.0
Slight	2.0 to 4.0
Moderate	4.0 to 8.0
High	8.0 to 16.0
Very high	More than 16.0

Sand. As a soil separate, individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate, and living matter acting upon parent material, as conditioned by relief over periods of time.

Soil blowing. Erosion caused by wind.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stone. Rock fragments larger than 10 inches in diameter, if rounded, and larger than 15 inches along the longer axis, if flat.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Stubble-mulch tillage. A method of tillage that loosens the subsoil and eradicates weeds by using subtillage sweeps, but leaves the crop stubble generally undisturbed.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, in most places about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are as follows: *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine." (See also, Clay, Sand, and Silt.)

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

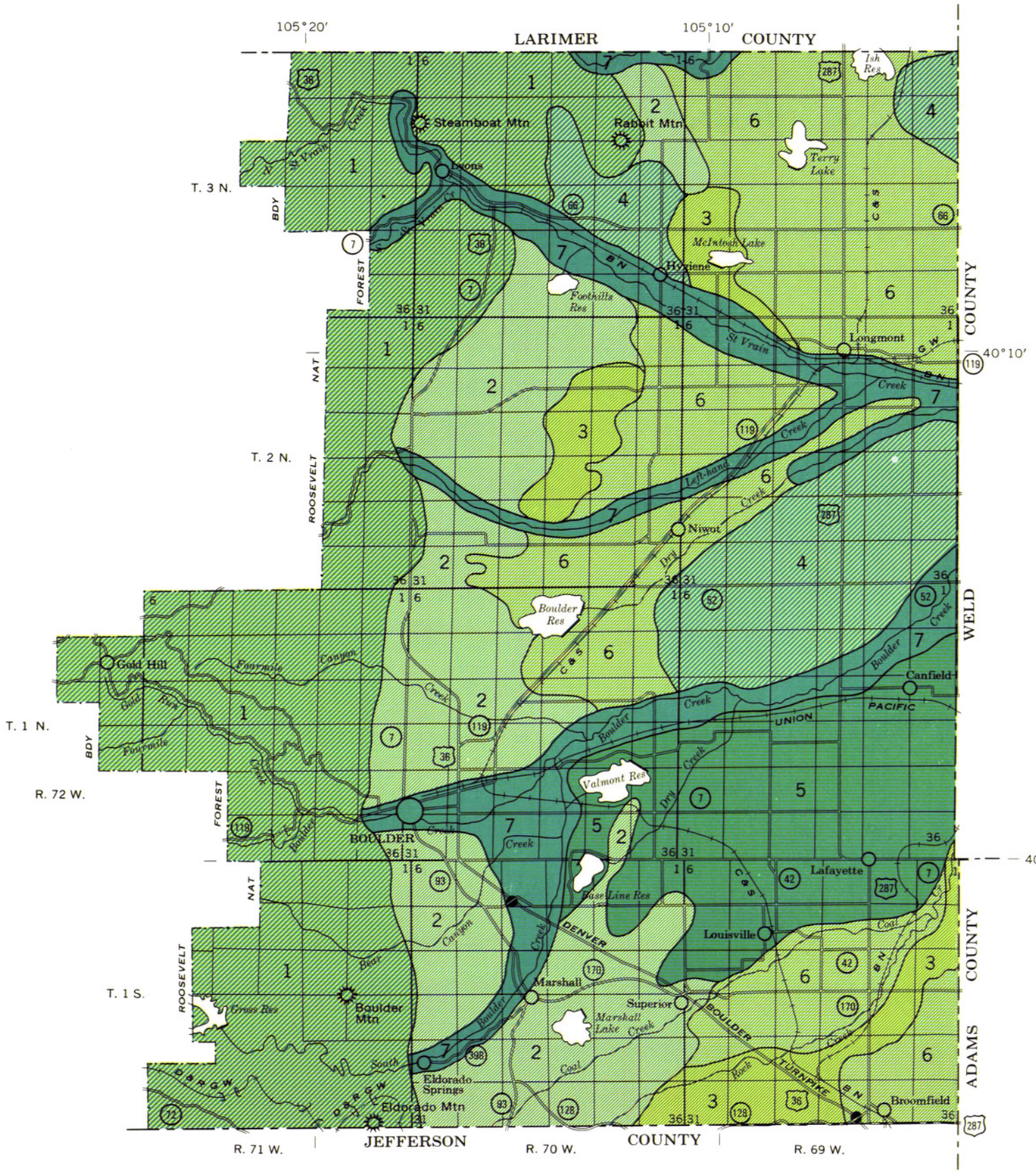
COLORADO AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

BOULDER AREA, COLORADO

Scale 1:190,080

1 0 1 2 3 4 Miles



This map is for general planning. It shows only the major soils and does not contain sufficient detail for operational planning.

N

SOIL ASSOCIATIONS

1. Rock outcrop-Juget-Baller association: Rock outcrop and sloping to very steep, shallow, very gravelly and stony soils on mountains
2. Nederland-Valmont association: Nearly level to moderately steep, deep, very cobbly and cobbly soils on old high terraces, alluvial fans, and benches
3. Samsil-Shingle association: Gently sloping to moderately steep, shallow soils on shale or sandstone hills and ridges
4. Weld-Colby association: Nearly level to sloping, deep soils on uplands
5. Ascalon-Nunn-Manter association: Nearly level to moderately steep, deep soils on terraces, valley sides, and uplands
6. Nunn-Heldt association: Nearly level to moderately sloping, deep soils on terraces and uplands
7. Niwot-Loveland-Calkins association: Nearly level, deep soils on low terraces and bottom lands

Compiled 1972

GUIDE TO MAPPING UNIT

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. Other information is given in tables, as follows:

Acreage and extent, table 1, page 6.
Predicted yields of irrigated crops, table 2, page 39.
Predicted yields of nonirrigated crops, table 3, page 46.
Soil limitations for recreational uses, table 4, page 49.
Engineering uses of the soils, tables 5 and 6, pages 54 through 67.
Soil limitations for urban uses, table 7, page 70.

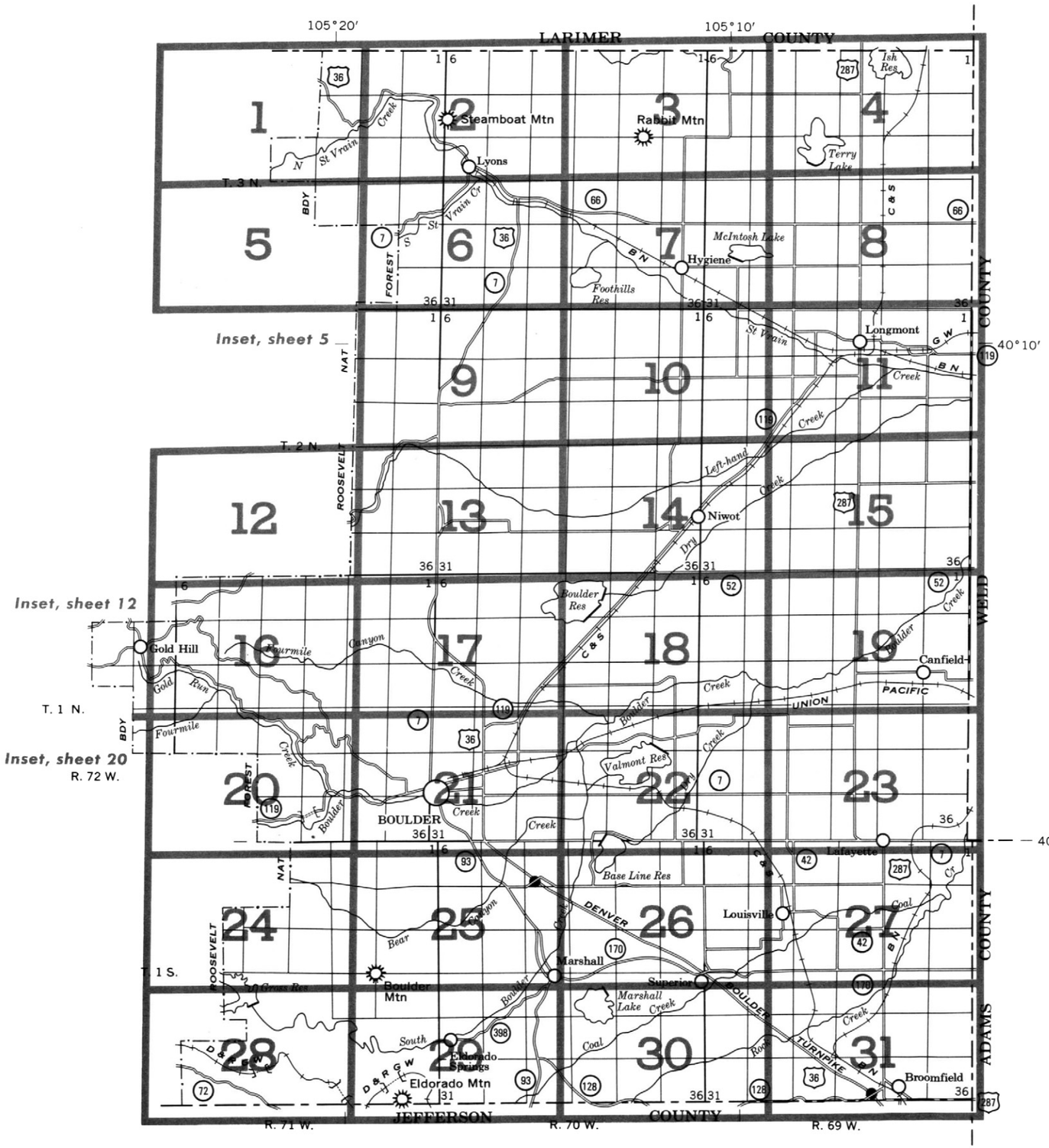
Map symbol	Mapping unit	Page	Capability unit: Irrigated Symbol	Irrigated Page	Nonirrigated Symbol	Nonirrigated Page	Tree suitability group Number
AcA	Ascalon sandy loam, 0 to 1 percent slopes	7	I	32	------	----	4
AcB	Ascalon sandy loam, 1 to 3 percent slopes	7	IIe-2	33	IIIe-8	40	4
AcC	Ascalon sandy loam, 3 to 5 percent slopes	7	IIIe-6	36	IVe-7	43	4
AcD	Ascalon sandy loam, 5 to 9 percent slopes	7	IVe-3	38	IVe-7	43	4
AoB	Ascalon-Otero complex, 0 to 3 percent slopes	7	IIe-2	33	IIIe-8	40	4
AoC	Ascalon-Otero complex, 3 to 5 percent slopes	7	IIIe-6	36	IVe-7	43	4
AoD	Ascalon-Otero complex, 5 to 9 percent slopes	8	IVe-3	38	IVe-7	43	4
AoE	Ascalon-Otero complex, 9 to 20 percent slopes	8	------	----	VIe-2	44	4
BaF	Baller stony sandy loam, 9 to 35 percent slopes	8	------	----	VIIs-1	45	6
CaA	Calkins sandy loam, 0 to 1 percent slopes	9	IIw-2	34	------	----	5
CaB	Calkins sandy loam, 1 to 3 percent slopes	9	IIw-2	34	------	----	5
CoB	Colby silty clay loam, 1 to 3 percent slopes	9	IIe-1	32	IVe-4	42	3
CoC	Colby silty clay loam, 3 to 5 percent slopes	9	IIIe-2	34	VIe-1	44	3
CoD	Colby silty clay loam, 5 to 9 percent slopes	9	IVe-1	37	VIe-1	44	3
CsB	Colby silty clay loam, wet, 0 to 3 percent slopes	10	IIw-1	33	------	----	6
Ct	Colby-Gaynor association	10	IVe-1	37	VIe-1	44	3
Cu	Colluvial land	10	------	----	VIIs-1	45	6
FcF	Fern Cliff-Allens Park-Rock outcrop complex, 15 to 60 percent slopes	11	------	----	VIIe-1	45	1
GaB	Gaynor silty clay loam, 1 to 3 percent slopes	11	IVs-1	38	IVe-4	42	3
GaD	Gaynor silty clay loam, 3 to 9 percent slopes	11	IVe-1	37	VIe-1	44	3
GrF	Goldvale-Rock outcrop complex, 9 to 55 percent slopes	12	------	----	VIIe-1	45	2
HaB	Hargreave fine sandy loam, 1 to 3 percent slopes	13	IIIe-9	36	IIIe-8	40	4
HaD	Hargreave fine sandy loam, 3 to 9 percent slopes	13	IVe-2	37	VIe-2	44	4
HeB	Heldt clay, 0 to 3 percent slopes	13	IIIe-1	34	IVe-4	42	6
HeC	Heldt clay, 3 to 5 percent slopes	13	IVe-1	37	VIe-1	44	6
JrF	Juget-Rock outcrop complex, 9 to 55 percent slopes	14	------	----	VIIs-1	45	2
KuD	Kutch clay loam, 3 to 9 percent slopes	15	IVe-1	37	VIe-1	44	3
LaE	Laporte very fine sandy loam, 5 to 20 percent slopes	15	------	----	VIe-3	44	6
LoB	Longmont clay, 0 to 3 percent slopes	16	------	----	VIw-1	44	6
Lv	Loveland soils	16	IIIw-1	36	------	----	5
Ma	Made land	16	IVw-1	38	VIIIs-1	45	---
MdA	Manter sandy loam, 0 to 1 percent slopes	17	IIIe-4	35	IIIe-8	40	4
MdB	Manter sandy loam, 1 to 3 percent slopes	17	IIIe-4	35	IIIe-8	40	4
MdD	Manter sandy loam, 3 to 9 percent slopes	17	IIIe-6	36	IVe-7	43	4
Me	Manvel loam	18	IIe-1	32	IVe-4	42	3
Mm	McClave clay loam	18	IIw-1	33	------	----	5
NdD	Nederland very cobbly sandy loam, 1 to 12 percent slopes	19	------	----	VIIs-1	45	6
Nh	Niwot soils	19	IVw-1	38	VIw-2	45	6
NnA	Nunn sandy clay loam, 0 to 1 percent slopes	20	I	32	------	----	3
NnB	Nunn sandy clay loam, 1 to 3 percent slopes	20	IIe-2	33	------	----	3
NuA	Nunn clay loam, 0 to 1 percent slopes	20	IIs-1	33	------	----	3
NuB	Nunn clay loam, 1 to 3 percent slopes	20	IIe-1	32	IIIs-1	41	3
NuC	Nunn clay loam, 3 to 5 percent slopes	21	IIIe-2	34	IIIe-7	40	3
NuD	Nunn clay loam, 5 to 9 percent slopes	21	IVe-1	37	VIe-1	44	3
Nv	Nunn-Kim complex	21	IIe-1	32	------	----	3
PgE	Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes	22	------	----	VIIs-1	45	2
PrF	Pinata-Rock outcrop complex, 5 to 55 percent slopes	23	------	----	VIIe-1	45	6
ReD	Renohill loam, 3 to 9 percent slopes	24	------	----	VIe-3	44	6
RnB	Renohill silty clay loam, 1 to 3 percent slopes	24	IVs-1	38	IVe-4	42	3
RnD	Renohill silty clay loam, 3 to 9 percent slopes	24	IVe-1	37	VIe-1	44	3
Ro	Rock outcrop	24	------	----	VIIIs-1	45	---
SaD	Samsil clay, 3 to 12 percent slopes	25	------	----	VIe-3	44	6
SeE	Samsil-Shingle complex, 5 to 25 percent slopes	25	------	----	VIe-3	44	6
SgE	Shingle-Gaynor complex, 3 to 20 percent slopes	25	------	----	VIe-3	44	6
SmF	Sixmile stony loam, 10 to 50 percent slopes	26	------	----	VIIs-1	45	6
Te	Terrace escarpments	26	------	----	VIIs-1	45	6
VaB	Valmont clay loam, 1 to 3 percent slopes	27	IIIe-3	34	IIIs-1	41	3
VaC	Valmont clay loam, 3 to 5 percent slopes	28	IIIe-2	34	IIIe-7	40	3
VcC	Valmont cobbly clay loam, 1 to 5 percent slopes	28	Vs-1	38	VIIs-1	45	6
VcE	Valmont cobbly clay loam, 5 to 25 percent slopes	28	------	----	VIIs-1	45	6
WdB	Weld loamy sand, 1 to 4 percent slopes	29	IIIe-5	36	IVe-9	44	4
WeB	Weld fine sandy loam, 1 to 3 percent slopes	29	IIe-2	33	IIIe-8	40	3
WlA	Weld loam, 0 to 1 percent slopes	29	IIs-1	33	IIIc-1	42	3
WlB	Weld loam, 1 to 3 percent slopes	29	IIe-1	32	IIIc-1	42	3
WoB	Weld-Colby complex, 0 to 3 percent slopes	29	IIe-1	32	IIIc-1	42	3
WoC	Weld-Colby complex, 3 to 5 percent slopes	30	IIIe-2	34	IIIe-7	40	3

INDEX TO MAP SHEETS
BOULDER AREA, COLORADO

Scale 1:190,080

1 0 1 2 3 4 Miles

N



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Most symbols without a slope letter are those of nearly level soils, but some are for land types that have a considerable range of slope.

SYMBOL	NAME
AcA	Ascalon sandy loam, 0 to 1 percent slopes
AcB	Ascalon sandy loam, 1 to 3 percent slopes
AcC	Ascalon sandy loam, 3 to 5 percent slopes
AcD	Ascalon sandy loam, 5 to 9 percent slopes
AoB	Ascalon-Otero complex, 0 to 3 percent slopes
AoC	Ascalon-Otero complex, 3 to 5 percent slopes
AoD	Ascalon-Otero complex, 5 to 9 percent slopes
AoE	Ascalon-Otero complex, 9 to 20 percent slopes
BaF	Baller stony sandy loam, 9 to 35 percent slopes
CaA	Calkins sandy loam, 0 to 1 percent slopes
CaB	Calkins sandy loam, 1 to 3 percent slopes
CoB	Colby silty clay loam, 1 to 3 percent slopes
CoC	Colby silty clay loam, 3 to 5 percent slopes
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HeC	Heldt clay, 3 to 5 percent slopes
JrF	Juget-Rock outcrop complex, 9 to 55 percent slopes
KuD	Kutch clay loam, 3 to 9 percent slopes
LaE	Laporte very fine sandy loam, 5 to 20 percent slopes
LoB	Longmont clay, 0 to 3 percent slopes
Lv	Loveland soils
Ma	Made land
MdA	Manter sandy loam, 0 to 1 percent slopes
MdB	Manter sandy loam, 1 to 3 percent slopes
MdD	Manter sandy loam, 3 to 9 percent slopes
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Mm	McClave clay loam
NdD	Nederland very cobbly sandy loam, 1 to 12 percent slopes
Nh	Niwot soils
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NuA	Nunn clay loam, 0 to 1 percent slopes
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Nv	Nunn-Kim complex
PgE	Peyton-Juget very gravelly loamy sands, 5 to 20 percent slopes
PrF	Pinata-Rock outcrop complex, 5 to 55 percent slopes
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VaC	Valmont clay loam, 3 to 5 percent slopes
VcC	Valmont cobbly clay loam, 1 to 5 percent slopes
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WdB	Weld loamy sand, 1 to 4 percent slopes
WeB	Weld fine sandy loam, 1 to 3 percent slopes
WlA	Weld loam, 0 to 1 percent slopes
WlB	Weld loam, 1 to 3 percent slopes
WoB	Weld-Colby complex, 0 to 3 percent slopes
WoC	Weld-Colby complex, 3 to 5 percent slopes

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Aqueduct tunnel

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Limit of soil survey
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony, Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Borrow pit (B.P.)
- Mine dump (M.D.)
- Land leveling
- Saline or alkali spot

BOULDER AREA, COLORADO — SHEET NUMBER 1

2 030 000 FEET

R. 71 W.

LARIMER COUNTY

LIMIT OF DETAILED SOIL SURVEY

ROOSEVELT NATIONAL FOREST BOUNDARY

T. 3 N.

(Joins sheet 2)

(Joins sheet 5)

335 000 FEET

325 000 FEET

2 050 000 FEET

Longmont Reservoir

St Vrain Creek

North

Park

Antelope

PgE

FcF

JrF

Ro

36

1 2 3 10 11 14 15 16

N

1 Mile

5 000 Feet

Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.
Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

BOULDER AREA, COLORADO — SHEET NUMBER 2

R. 71 W. | R. 70 W.

2 075 000 FEET

LARIMER COUNTY

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

(Joins sheet 1)

335 000 FEET

T. 3 N.

(Joins sheet 3)

325 000 FEET

(Joins sheet 6)

2 055 000 FEET

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

Indian Mountain

Stone Canyon

North St Vrain Creek

South St Vrain Creek

Steamboat Mountain

Indian Lookout Mountain

Lyons

BURLINGTON NORTHERN

CANAL

SUPPLY

ST VRAIN

PgE FeF JrF Ro Cu PrF SmF BaF VcC VcE GaD LaE CaB NnB NuB Nh Me AcC

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.
Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

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BOULDER AREA, COLORADO — SHEET NUMBER 5

BOULDER AREA, COLORADO NO. 5

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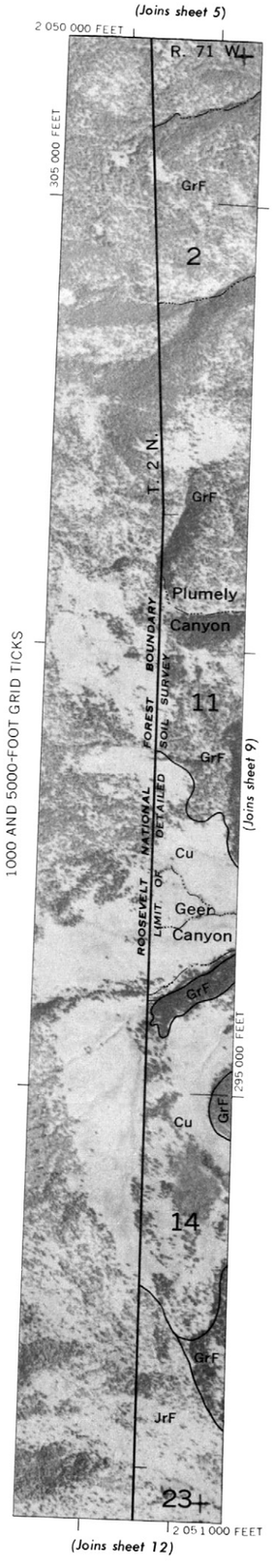
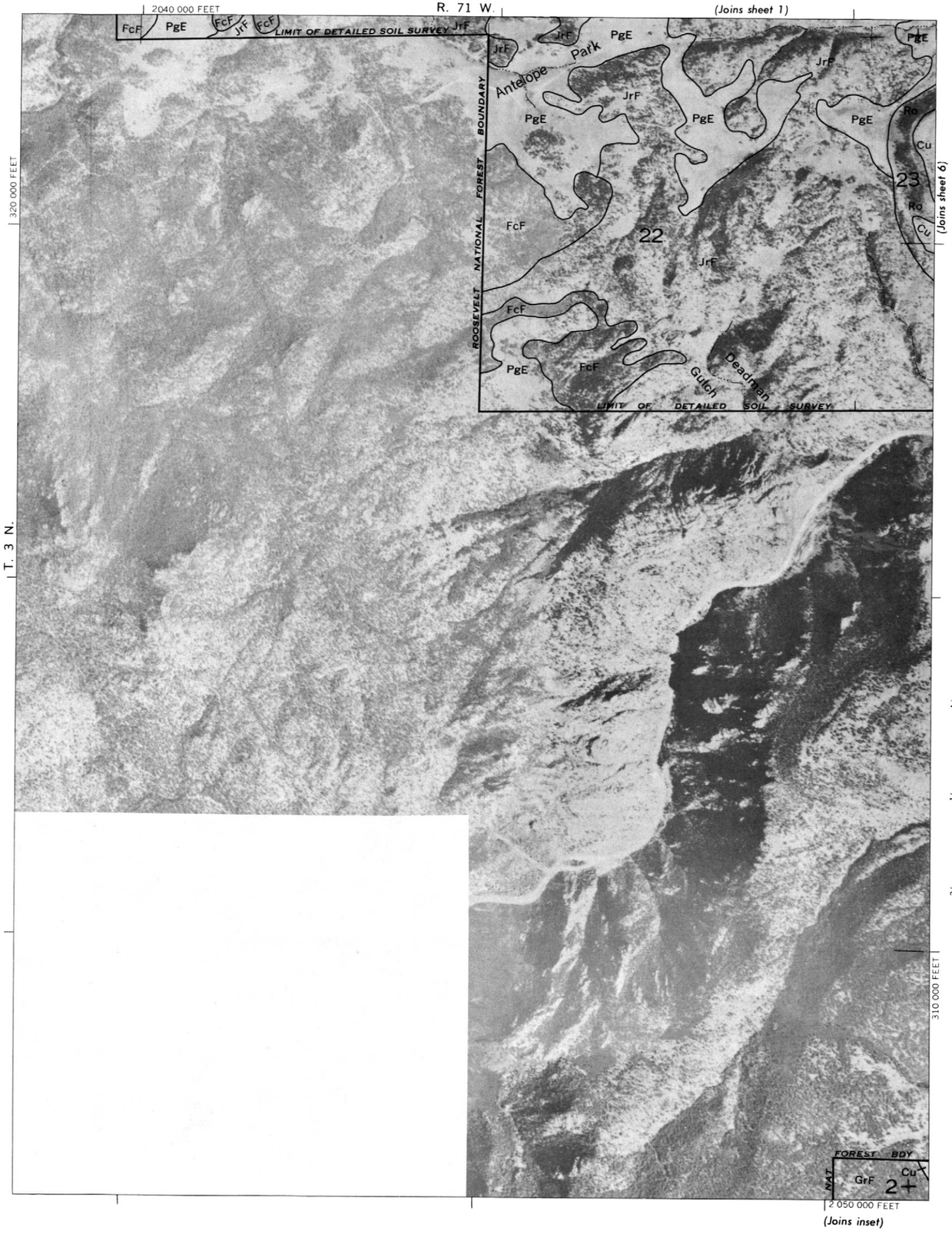
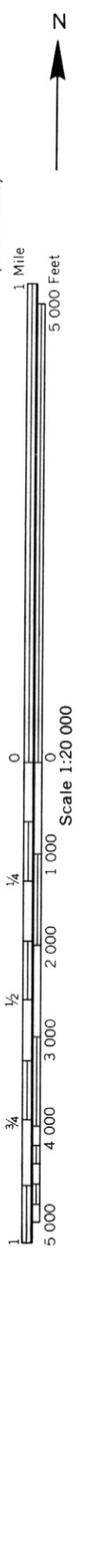
Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.







BOULDER AREA, COLORADO — SHEET NUMBER 6

(Joins sheet 2)

R. 71 W. | R. 70 W.

2 075 000 FEET

2 055 000 FEET

(Joins sheet 9)

(Joins sheet 7)

T. 3 N.

320 000 FEET

310 000 FEET

(Joins sheet 5)

N

Scale 1:20 000

1 Mile

5 000 Feet

1 000 Feet

2 000 Feet

3 000 Feet

4 000 Feet

5 000 Feet

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO NO. 6

ROOSEVELT NATIONAL FOREST BOUNDARY

LIMIT OF DETAILED SOIL

BOULDER AREA, COLORADO — SHEET NUMBER 7

R. 70 W. | R. 69 W.

2 080 000 FEET

320 000 FEET

T. 3 N.

(Joins sheet 3)

(Joins sheet 8)

(Joins sheet 6)

(Joins sheet 10)

2 100 000 FEET

310 000 FEET

N

Scale 1:20 000

1 Mile

5 000 Feet

BOULDER AREA, COLORADO NO. 7

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Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone

Land division corners are approximately positioned on this map.

(8)

N

(Joins sheet 4)

R. 69 W.

2 125 000 FEET

320 000 FEET

T. 3 N.

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 7)

310 000 FEET

(Joins sheet 11)

2 105 000 FEET

Clark Reservoir

McIntosh Lake

LONGMONT

COLORADO AND SOUTHERN

Spring Gulch

WELD COUNTY

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO NO. 8

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Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

(Joins insert, sheet 5)
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 13)

2 055 000 FEET
305 000 FEET
R. 71 W. | R. 70 W.
T. 2 N.
2 075 000 FEET
295 000 FEET

Cu PrF GrF SmF BaF NuC NuB VcC VcE VaC VaB VaE LaE LoB SaD SeE Te Me RnD HaD KuD NdD Mm Ro JrF AoC

Plumley Canyon
Geer Canyon
Left-hand Creek
Lykins Gulch
Lykins
Potato Hill
BORROW PIT
Lake Allens Lake
Altona
TABLE MOUNTAIN
TABLE MOUNTAIN ANTENNA FIELD SITES
GRAVEL PIT
DITCH

1 2 11 12 6 5 4 1 32 33 7 8 9 13 18 17 16 14

1 Mile
5 000 Feet
Scale 1:20 000
0 ¼ ½ ¾ 1
0 1 000 2 000 3 000 4 000 5 000

9
N

(10)

N

R. 70 W. | R. 69 W.

T. 2 N. | T. 3 N.

2 100 000 FEET

305 000 FEET

295 000 FEET

2 080 000 FEET

(Joins sheet 7)

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 14)

Scale 1:20 000

1 Mile — 5 000 Feet

1 000 — 2 000 — 3 000 — 4 000 — 5 000

Trevarton Reservoir

Davis Reservoir

Clover Basin Reservoir

Born Lake

Swede Lakes

Steele Lakes

Lagerman Reservoir

LONGMONT MUNICIPAL AIRPORT

Lykins Ditch

Boulder Supply Ditch

Boulder Ro Swede Ditch

Peck Ditch

Clover Basin Ditch

Nub Ditch

James int Ditch

Flat Ditch

Niwot Ditch

Burlington Northern

St Vrain Creek

Dry Creek

Table Mountain Canal

Boulder Supply Ditch

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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(11)

N

Scale 1:20 000

1 Mile

0 ¼ ½ ¾ 1

5 000 Feet

0 1 000 2 000 3 000 4 000 5 000

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Land division corners are approximately positioned on this map

(Joins insert, sheet 5)

N

R. 72 W.

2 025 000 FEET

ROOSEVELT NATIONAL FOREST BOUNDARY
LIMIT OF DETAILED SOIL SURVEY

11 Gold Hill 12

13 14

FcF JrF PgE

Gold Run

265 000 FEET

T. 1 N.

260 000 FEET

LIMIT OF DETAILED SOIL SURVEY
ROOSEVELT NATIONAL FOREST BOUNDARY

(Joins sheet 16)

24

2 020 000 FEET

(Joins inset, sheet 20)

1 Mile
5 000 Feet

Scale 1:20 000

1 0 1 2 3 4 5 000 Feet

275 000 FEET

2 030 000 FEET

R. 71 W.

2 050 000 FEET

290 000 FEET

JrF Spruce Gulch FcF

23 26 35 2

Cr Trib Left Hand Creek

FcF JrF PgE GrF Cu

ROOSEVELT NATIONAL FOREST BOUNDARY
LIMIT OF DETAILED SOIL SURVEY

(Joins sheet 13)

6 5 4 3 2

Left hand Creek

T. 1 N. | T. 2 N.

(Joins sheet 16)

Land division corners are approximately positioned on this map

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO — SHEET NUMBER 13

R. 71 W. | R. 70 W.

2 055 000 FEET

290 000 FEET

(Joins sheet 9)

13

N

TABLE MOUNTAIN ANTENNA FIELD SITES

Left-hand Canyon

Left-hand Creek

Sixmile Canyon

Left-hand Valley Reservoir

GOLF COURSE

GRAVEL PIT

LAKE DITCH

TABLE MOUNTAIN DITCH

CROCKER DITCH

HOLLAND DITCH

HINMAN DITCH

FARMERS DITCH

Little Dry Creek

(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 17)

T. 1 N. | T. 2 N.

2 075 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

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Land division corners are approximately positioned on this map.

N

R. 70 W. | R. 69 W.

2 100 000 FEET

1290 000 FEET

(Joins sheet 10)

(Joins sheet 13)

(Joins sheet 15)

(Joins sheet 18)

2 080 000 FEET

275 000 FEET

Scale 1:20 000

1 Mile 5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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T. 1 N. | T. 2 N.

BOULDER AREA, COLORADO — SHEET NUMBER 15

2 105 000 FEET

290 000 FEET

R. 69 W.

(Joins sheet 11)

(Joins sheet 14)

T. 2 N.

(Joins sheet 19)

2 125 000 FEET

275 000 FEET

15 N

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Gaynor Lake

Panama Reservoir No 1

Dry Creek

LIGGETT DITCH

WHITEROCK DITCH

HOLDT DITCH

BOULDER AND WHITEROCK DITCH

BOULDER CR

WELD COUNTY

16

N

R. 72 W. | R. 71 W.

NATIONAL FOREST BOUNDARY
LIMIT OF DETAILED SOIL SURVEY

ROOSEVELT

Left-hand Creek
Glendale
Glendale Gulch
Rowena
Sunshine
Summerville
Gold Run
Salina
Fourmile Creek
Fourmile Canyon
Crisman

(Joins inset sheet 12)
(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 20)

2 050 000 FEET
2 030 000 FEET
270 000 FEET
260 000 FEET

T. 1 N.

JrF
FcF
PgE
GrF
Cu

1 Mile
5 000 Feet
Scale 1:20 000

Land division corners are approximately positioned on this map.
Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
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BOULDER AREA, COLORADO — SHEET NUMBER 17

R. 71 W. | R. 70 W.

2 055 000 FEET

2 075 000 FEET

270 000 FEET

260 000 FEET

T. 1 N.

(Joins sheet 13)

(Joins sheet 16)

(Joins sheet 18)

(Joins sheet 21)

N

1 Mile

5 000 Feet

Scale 1:20 000

BOULDER (county seat)

Boulder Reservoir

Mesa Reservoir

Sixmile Res

Wonderland Lake

Maxwell Reservoir

Maxwell Lake

Fourmile Canyon Creek

Twomile Canyon

Silver Lake Ditch

Farmers Ditch

City Dump

Gravel Pit

Boulder and Colorado Southern Ditch

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.
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Land division corners are approximately positioned on this map.

BOULDER AREA, COLORADO — SHEET NUMBER 18

(18)

N

(Joins sheet 14)

R. 70 W. | R. 69 W.

2 100 000 FEET

Boulder Reservoir

Sixmile Reservoir

Fourmile Canyon Creek

Twin Lakes

Sawhill Lakes

Dry Creek

Boulder Creek

Sewage Disposal

GRAVEL PIT

BORROW PIT

SPILLWAY

DITCH

CANAL

SUPPLY

LATERAL

BOULDER AND WHITEROCK DITCH

LEFT-HAND DITCH

BOULDER AND LEFT-HAND DITCH

BOULDER AND SOUTHERN SUPPLY DITCH

BOULDER AND COLORADO DITCH

UNION PACIFIC

SOUTHERN

COLORADO

LIGGETT DITCH

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 22)

260 000 FEET

270 000 FEET

2 080 000 FEET

T. 1 N.

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

Land division corners are approximately positioned on this map

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO — SHEET NUMBER 19

(Joins sheet 18)

T. 2 N. | T. 1 N. | R. 69 W.

2 105 000 FEET | 270 000 FEET

(Joins sheet 15)

(Joins sheet 23)

2 125 000 FEET | 260 000 FEET

Gooding | Leyner | Liggett | Canfield | Tabor | Erie

BOULDER AND WHITEROCK DITCH | BOULDER AND WELD DITCH | BOULDER CREEK | Coal Creek | WELD COUNTY DITCH | PACIFIC UNION LOWER BOULDER DITCH | COTTONWOOD NO. 1 DITCH | LEYNER DITCH

Scale 1:20 000 — 1 Mile — 5 000 Feet

20

N

R. 72 W. | R. 71 W.

(Joins inset)

(Joins sheet 16)

2 050 000 FEET

255 000 FEET

Fourmile Creek

Wallstreet

Sunshine Canyon

Fourmile Creek

Bummers Gulch

Boulder Creek

Orodell

El Vado

Silver Spruce

BOULDER MOUNTAIN PARK

INDEFINITE BOUNDARY

ROOSEVELT NATIONAL FOREST BOUNDARY

LIMIT OF DETAILED SOIL SURVEY

SOIL SURVEY

JrF

FcF

PgE

24 19 20 21 22 23 28 27 26 33 34 35 4 3 2

119

R. 72 W.

(Joins inset, sheet 12)

2 027 000 FEET

257 000 FEET

255 000 FEET

2 025 000 FEET

Fourmile Cr

(Joins upper left)

T. 1 N.

2000-FOOT GRID TICKS

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

245 000 FEET

2 030 000 FEET

T. 1 S. | T. 1 N.

(Joins sheet 21)

(Joins sheet 24)

Land division corners are approximately positioned on this map.

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2 055 000 FEET

R. 71 W. | R. 70 W.

(Joins sheet 17)

255 000 FEET

(Joins sheet 20)

(Joins sheet 22)

T. 1 S. | T. 1 N.

(Joins sheet 25)

2 075 000 FEET

BOULDER (county seat)

BOULDER

MOUNTAIN PARK

UNIVERSITY OF COLORADO

BOULDER MUNICIPAL AIRPORT

Maxwell Lake

Sunshine Lake

Sale Lake

Hauden Lake

Sunshine Canyon

Gregory Canyon

Flagstaff Mountain

Boulder Creek

Bear Canyon Creek

Skunk Creek

Silver Lake Ditch

Farmers Ditch

Whiterock Ditch

Left Hand Ditch

Boulder and Southern Ditch

Boulder and Colorado Ditch

Empson Ditch

Mountain View Cemetery

Columbia Cemetery

Gravel Pit

Boulder and Colorado and Southern

Pacific Union

Indefinite Boundary

Boundary

PgE, PrF, JrF, GrF, FcF, SmF, BaF, NdD, NuB, NuC, NuD, VcC, VaB, VaC, Te, Cu, Ro, Lv, Ara, Nh, Mm

N

1 Mile

5 000 Feet

Scale 1:20 000

N

R. 70 W | R. 69 W

2 100 000 FEET

255 000 FEET

245 000 FEET

2 080 000 FEET

(Joins sheet 18)

(Joins sheet 21)

(Joins sheet 23)

(Joins sheet 26)

1 Mile 5 000 Feet

Scale 1:20 000

0 1 000 2 000 3 000 4 000 5 000

0 ¼ ½ ¾ 1

T. 1 S. | T. 1 N.

BOULDER MUNICIPAL AIRPORT

B. M. AIRPORT

MUNICIPAL GOLF COURSE

Fairview High School

Vocational Technical School

Fairview School

Douglas School

Boulder Junction

Substation

Valmont

Valmont Butte

VALMONT CEMETERY

Leggett Reservoir

Owen Reservoir

Valmont Reservoir

Hillcrest Lake

Base Line Reservoir

Sawhill Lakes

Teller Lake No 5

Teller Lake

Burke Lake

Boulder Creek

South Boulder Creek

Fourmile Canyon Creek

Dry Creek

Left Hand Ditch

Boulder and Left Hand Ditch

Boulder and South Boulder Ditch

Boulder and South Boulder Canyon Ditch

Boulder and South Boulder Enterprise Ditch

Boulder and South Boulder Leyner Ditch

Boulder and South Boulder Marshallville Ditch

Boulder and South Boulder Union Ditch

Boulder and South Boulder Cottonwood No 1 Ditch

Colorado and Southern Ditch

Colorado and Southern Davidson Ditch

Colorado and Southern Goodhue Ditch

Colorado and Southern High Line Lateral

Colorado and Southern Mc Ginn Ditch

Empson Ditch

Gravel Pit

Land division corners are approximately positioned on this map

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone

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BOUNDER AREA, COLORADO — SHEET NUMBER 23

(Joins sheet 19)
(Joins sheet 22)
(Joins sheet 27)

2 105 000 FEET
255 000 FEET
245 000 FEET
2 125 000 FEET

R. 69 W.

T. 1 S. | T. 1 N.

Teller Lake No 5
Thomas Reservoir
Elmwood Reservoir
Hiram Prince Lake
Erie Lake
Ninemile Corner
Prince Lake No 1
Marfelt Lakes

LEYNER
COTTONWOOD
NO 1 DITCH
DITCH
MC GINN
Bullhead
SOUTH BOULDER CANYON
HIGHLINE
GOODHUE
LATERAL
BOULDER CANYON
BURLINGTON NORTHERN
Coal Creek
WELD COUNTY
ADAMS CO
LAFAYETTE

Scale 1:20 000
1 Mile
5 000 Feet
0 ¼ ½ ¾ 1
0 1 000 2 000 3 000 4 000 5 000

23
N

N

1 Mile

5 000 Feet

Scale 1:20 000

R. 71 W.

(Joins sheet 20)

2 050 000 FEET

240 000 FEET

T. 1 S.

ROOSEVELT NATIONAL FOREST BOUNDARY

INDEFINITE BOUNDARY

LIMIT OF DETAILED SOIL SURVEY

BOULDER MOUNTAIN PARK

Kossler Lake

Bear Canyon

Meyers Gulch

Woods Gulch

Retallack Gulch

Gross Reservoir

Harmon Gulch

BOULDER MOUNTAIN PARK

FcF

JrF

PgE

8 9 10 11 14 15 16 17 23

2 030 000 FEET

225 000 FEET

(Joins sheet 25)

(Joins sheet 28)

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO — SHEET NUMBER 25

R. 71 W. | R. 70 W.

2 055 000 FEET

(Joins sheet 21)

25

N

T. 1 S.

2 240 000 FEET

(Joins sheet 24)

(Joins sheet 26)

2 230 000 FEET

2 075 000 FEET

(Joins sheet 29)

1 Mile

5 000 Feet

Scale 1:20 000

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Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

PSE

Ro

GrF

Cu

NdD

City Reservoir

GREEN MOUNTAIN MEMORIAL PARK CEMETERY

NATIONAL BUREAU OF STANDARDS

NuB

Mtn

Boulder Creek

DENVER-BOULDER TURNPIKE

VaB

Nh

Te

Kohler Reservoir

Cu Canyon

Bear Canyon

Skunk Creek

GRAVEL PIT

BOULDER

(county seat)

FcF

JrF

Green Mountain

The Flatirons

MOUNTAIN PARK

BaF

SmF

Table Mtn

Institute for Environmental Research

Viele Lake

Lv

VaC

KuD

Fern Canyon

Harmon Gulch

BOULDER MOUNTAIN

INDEFINITE BOUNDARY

Marshall

South Boulder Creek

MARSHALL DITCH

GOODHUE DITCH

HaB

HaD

(26)

N

(Joins sheet 22)

R. 70 W. | R. 69 W.

2 100 000 FEET

240 000 FEET

T. 1 S.

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 30)

230 000 FEET

2 080 000 FEET

Base Line Reservoir

Louisville Reservoir

Harper Lake

Paragon Estates

Cowdry Res

Marshall Lake

Louisville

Superior

Boulder Creek

South Boulder Creek

DAVIDSON MESA

DENVER-BOULDER TURNPIKE

DAVIDSON

GOODHUE

MARSHALLVILLE

COMMUNITY

GRAVEL PIT

DITCH

LATERAL

CANYON

CREEK

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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BOULDER AREA, COLORADO — SHEET NUMBER 27

2 105 000 FEET

R. 69 W.

(Joins sheet 23)

27

N

240 000 FEET

T. 1 S.

(Joins sheet 26)

LOUISVILLE

LAFAYETTE

Miller and Harmon Reservoir

LATERAL DITCH

HIGHLINE DITCH

GOODHUE DITCH

COLORADO AND SOUTHERN RAILROAD

NORTHERN

BURLINGTON ROCK ISLAND

SOUTHERN PACIFIC

LOUISVILLE CEMETERY

Coal Creek

Rock Creek

ADAMS COUNTY

(Joins sheet 31)

2 125 000 FEET

230 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

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Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

BOUNDER AREA, COLORADO — SHEET NUMBER 28

N

R. 71 W.

(Joins sheet 24)

2 050 000 FEET

225 000 FEET

T. 1 S.

(Joins sheet 29)

1 Mile

5 000 Feet

Scale 1:20 000

2 030 000 FEET

210 000 FEET

ROOSEVELT NATIONAL FOREST BDY

LIMIT OF DETAILED SOIL SURVEY

DENVER AND RIO GRANDE WESTERN

Gross Reservoir

Castle Rock

Tom Davis Gulch

South Boulder Creek

Martin Gulch

Miramonte

Advent Gulch

Nineteen

Crescent

Crescent Village

Coal Creek

Johnson Gulch

Copperdale

JEFFERSON COUNTY

JrF

FcF

PgE

Ro

23

72

Land division corners are approximately positioned on this map

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

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Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.
Land division corners are approximately positioned on this map.

(Joins sheet 28)

(Joins sheet 25)

(Joins sheet 30)

2 055 000 FEET

225 000 FEET

R. 71 W. | R. 70 W.

T. 1 S.

BOULDER MOUNTAIN PARK

INDEFINITE BOUNDARY

North Draw

South Boulder Creek

water

SOUTH BOULDER DIVERSION

WESTERN RIO GRANDE AND DENVER

Eldorado Mountain

JEFFERSON COUNTY

Eldorado Springs

Boulder Creek

South Boulder Creek

Spring Brook

Dowdy Draw

COMMUNITY DITCH

GOODHUE DITCH

DAVIDSON DITCH

Landing Strip

Coal Creek

19 20 21 23 24 28 29 30 31 32 33

FcF JrF Ro GrF Cu BaF SmF VcE NdD Te Nh KuD NuD HaD HaB

398 93 128

210 000 FEET

2 075 000 FEET

29

N

1 Mile

5 000 Feet

Scale 1:20 000

R. 70 W. | R. 69 W.

T. 1 S.

2 100 000 FEET

225 000 FEET

(Joins sheet 26)

(Joins sheet 29)

(Joins sheet 31)

210 000 FEET

2 080 000 FEET

JEFFERSON COUNTY

MARSHALL LAKE

Eggleston Res No 4

Hodgson-Harris Reservoir

Autrey Res

Mesa Lake

Coal Creek

Rock Creek

COMMUNITY DITCH

DENVER SOUTH TURNPIKE

SUPERIOR FEM

Scale 1:20 000

1 Mile

5 000 Feet

Land division corners are approximately positioned on this map.

Photobase from 1969 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Colorado coordinate system, north zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

BOULDER AREA, COLORADO — SHEET NUMBER 31

(Joins sheet 27)
(Joins sheet 30)

2 105 000 FEET — R. 69 W. — 2 125 000 FEET — 2 210 000 FEET

225 000 FEET — T. 1 S.

31 N

1 Mile — 5 000 Feet

Scale 1:20 000

Stearns Lake — Rock Creek — Aubrey Res — Missen Reservoir No. 2 — Broomfield Reservoir — Brunner Res

BROOMFIELD HEIGHTS — BROOMFIELD

ADAMS COUNTY — JEFFERSON COUNTY

GOODHUE DITCH — SOUTHERN SUPPLY — COLORADO — BURLINGTON — NORTHERN — DENVER-BOULDER TURNPIKE — BROOMFIELD — HIGHLINE — COMMUNITY — CANAL DITCH